**3GPP TSG-RAN WG4 Meeting # 96-e R4-2012744**

**Electronic Meeting, 17 – 27 August, 2020** (revision of R4-2012561)

**Agenda item:** 13.1

**Source:** Moderator (Apple Inc.)

**Title:** Email discussion summary for [96e][330] FR2\_enhTestMethods

**Document for:** Information

# Introduction

*The email discussion on Rel-17 enhanced test methods for FR2 is organized as follows:*

*Topic #1 covers aspects related to the high DL power and low UL power test cases (including the scope of remaining issues, UE beam management sensitivity, and path loss comparisons).*

*Topic #2 covers aspects related to polarization mismatch (including aspects related to the EIRP measurements and UL demodulation by test equipment).*

*Topic #3 covers aspects related to the test setup for inter-band DL CA in FR2 (including aspects related to 1 AoA vs. distributed AoAs).*

*Three documents were submitted to the top level agenda, and the moderator’s recommendations are captured in Topic #4 (although this topic is not used for email discussion).*

# Topic #1: High DL power and low UL power test cases

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2009960](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2009960.zip) | Apple Inc. | **Remaining issues with the test methodology for high DL power and low UL power test cases**Proposal 1: Progress the work on the high DL power / low UL power objective in two tracks: one examining possible enhancements to the permitted test methods listed in TR38.810 and another focusing on alternative methods. |
| [R4-2010856](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2010856.zip) | MVG Industries, Sony | **Summary and Further Results on Impact of phase variation on beam pattern for NF test method**Observation 1: Beam patterns and spherical coverage curve are not sensitive to a phase curvature of 65deg at 28GHz which corresponds to 0.3m range lengthObservation 2: Beam patterns and spherical coverage curve are not sensitive to a phase curvature of 59deg at 38GHz which corresponds to 0.3m range lengthProposal 1: the following factors shall be taken into account for the simulation setup for studying the phase curvature impact:* Simulated Frequency: 28 GHz, and 38GHz
* DUT size: length: 150 mm; width: 70 mm; height: 7mm
* Array inter-element distance: λ/2
* Array size: 4x1 linear array at 28GHz and 38GHz
* Array offset (wrt DUT’s physical center): (x=-75; y=-35; z=0) mm
* Measurement antenna
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| [R4-2011218](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2011218.zip) | Keysight Technologies | **On Test methodology for high DL power and low UL power test cases**Observation 1: White box testing generally requires the declaration by the manufacturer which antenna panel is active in any UL/DL test direction and the detailed locations of the panels within the DUT for full test case coverageObservation 2: For CATR test systems based on IFF test methodology white box vs black box testing makes little differenceObservation 3: For DFF and DNF systems, white box testing could eliminate the offset MU and potentially yield quality of quiet zone MUs for DFF and DNF based test systems similar to those of CATR based test systemsObservation 4: Feedback whether enhanced testability methods need to perform beam peak searches and spherical coverage tests was inconclusive.Observation 5: If white box test approach is selected for an enhanced NF test methodology, x-y-z positioning systems to fully automate test cases will likely affect the Quality of QZ MU and increase test system complexity.Observation 6: If white box test approach is selected for an enhanced NF test methodology, a vendor declaration is required which antenna panel is active in any UL/DL test direction and the detailed locations of the panels within the DUT.Observation 7: For white box testing, the min. range lengths for NF systems capable of single direction, TRP, and spherical coverage test cases is larger than for black box testingObservation 8: The reduction in pathloss for NF systems is about 13dB (11dB) for black (white) box testing when compared to IFF.Observation 9: Performing black-box DNF measurements with a UE and offset antennas in the known beam peak direction can yield incorrect EIRP/EIS measurementsObservation 10: Performing accurate black-box DNF measurements with a UE and offset antennas requires local searches around the known beam peak direction to improve EIRP/EIS measurements.Observation 11: When performing DNF measurements of NR FR2 devices utilizing beam forming, the beam forming of the UE towards the DNF measurement probe could result in measurements of undesired beams and incorrect EIRP/EIS beam peak measurementsObservation 12: Assuming a 30cm QZ diameter and a 20cm range length, near-field path loss differences up to ~17dB can be observed.Observation 13: The novel NF testing approach with Transform shows very promising measurement accuracies for NF EIRP measurementsObservation 14: The novel NF testing approach with Transform can accurately predict the offset of the antenna array from the centre of QZ.Observation 15: Large uncertainties can be observed for TRP for measurements performed in the NF utilizing the black back box approach.Observation 16: With the offset of the antenna array known, e.g., estimated with the enhanced NF methodology introduced in this contribution, very accurate TRP measurements in the NF can be made with a TRP offset compensation approachProposal 1: Keep the black box test approach for NR FR2 conformance testingProposal 2: Adopt the effective antenna aperture approach, i.e., taking into account the frequency dependence of the max antenna array aperture, for DNF and possibly DFF range length determinationsProposal 3: DNF systems to utilize an FF probe and UBF activation that allows the UE to select the intended beam.Proposal 4: The DNF testing methodology without any transform cannot be considered for NR FR2 testing for EIRP/EIS based metrics.Proposal 5: Feedback from industry is requested whether to continue efforts in terms of simulations and empirical investigations on this enhanced NF methodology with transformProposal 6: When performing TRP measurements in the NF, the offsets should be compensated to improve the measurement uncertainty. |
| [R4-2011281](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2011281.zip) | Rohde & Schwarz | **Views on test methods for high DL power and low UL power TCs**Proposal []: RAN4 to focus on solving testability issues for the following test cases:* + Transmit OFF power.
	+ (Receiver) Spurious emissions
	+ Spurious emission band UE co-existence
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| [R4-2011456](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2011456.zip) | Qualcomm Incorporated | **FR2 testability enhancement for UE emissions**Observation 1: It is beneficial to pursue alternative solutions to reduce the gap between testability limits and core requirements, even if the result is only a partial reduction in the gap. |

## 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 1-1: Scope of remaining issues

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 1-1-1: Whether the scope of the impacted high DL power and low UL power test cases can be further narrowed**

* Proposals
	+ Alt 1-1-1-1: According to WF in R4-1913070:
		- 6.3.2 Transmit OFF power
		- 6.5.1 Occupied bandwidth
		- 6.5.2.3 Adjacent channel leakage ratio
		- 6.5.3.2 Additional spurious emissions
		- 7.5 Adjacent channel selectivity (case 1)
		- 7.6.2 In-band blocking
		- 7.9 Receiver spurious emissions
	+ Alt 1-1-1-2: According to R4-2011281 (R&S):
		- Transmit OFF power.
		- (Receiver) Spurious emissions
		- Spurious emission band UE co-existence

**Issue 1-1-2: Whether specialized test systems can be considered**

* Proposals
	+ Alt 1-1-2-1: Yes
	+ Alt 1-1-2-2: No

**Issue 1-1-3: Whether manufacturer declarations can be considered**

* Proposals
	+ Alt 1-1-3-1: Yes
	+ Alt 1-1-3-2: No
	+ Alt 1-1-3-3: further study which detailed information from the vendor declaration is necessary should be discussed and decided

### Sub-topic 1-2: UE beam management sensitivity to magnitude/phase variation of the DL signal

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-2-1: Whether a study on study on UE beam management sensitivity to magnitude/phase variation of the DL signal needed**

* Proposals
	+ Alt 1-2-1-1: Yes
	+ Alt 1-2-1-2: No

**Issue 1-2-2: Simulation assumptions**

* Proposal: According to R4-2010856 (MVG, Sony)

### Sub-topic 1-3: Common understanding of path loss comparison across system types

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-3-1: Whether RAN4 can reach a common understanding on the path loss comparison across IFF/DFF and NF system types**

* Proposals
	+ Alt 1-3-1-1: According to R4-2011218:

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| ***f* [GHz]** | **Antenna Config. 1, 2, and 3- BLACK BOX -** **(PC3 Devices: D=5cm)** | **Antenna Config. 1 and 2- WHITE BOX - (PC3 Devices: D=5cm)** |
| **IFF/DFF** | **NF** | **DFF** | **NF** |
| **Path Loss with 1m range length** | **Path Loss with 0.22m range length** | **Path Loss with 0.88m range length** | **Path Loss with 0.28m range length** |
| **24.25** | 60.16 | 46.86 | 59.01 | 48.93 |
| **30** | 62.01 | 48.71 | 60.85 | 50.78 |
| **40** | 64.51 | 51.21 | 63.35 | 53.28 |
| **43.5** | 65.24 | 51.94 | 64.08 | 54.00 |
| **52.6** | 66.89 | 53.59 | 65.73 | 55.65 |

* + Alt 1-3-1-2: Further study is needed

## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company Comments** |
| Issue 1-1-1: Whether the scope of the impacted high DL power and low UL power test cases can be further narrowed | Keysight: Alt 1-1-1-1: the SI should focus on test cases that RAN informed industry about and that require relaxations. Limiting the test cases to just regulatory test cases was not the original intent. Even though ACS relaxations have improved, we should continue to keep ACS in the mix as relaxations are >0dB. OBW might have to be added pending discussions in RAN5. vivo: prefer Alt 1-1-1-1. The goal of the SI is developing test methods to cover all the TCs, or at least decreasing the gap between test method capability and TC requirements. Therefore, the group should keep working on all the problematic high DL power and low UL power test cases, to see if potential “reduction” of the relaxation identified by RAN5 can be achieved.Samsung: not sure how the two alternatives conflicts. It is better to cover all TCs but it may be also beneficial for achievement if regulatory test cases can be prioritized.Qualcomm: Alt 1-1-1-1Would KS and R+S clarify which regulators mandate transmit OFF power and UE co-ex?MediaTek: Similar view as Samsung, “It is better to cover all TCs but it may be also beneficial for achievement if regulatory test cases can be prioritized.”R&S: in response to Qualcomm’s comment, ETSI EN 301 908 -25 latest draft version mandates UE co-existence, but also Minimum Output Power that has the same issues as OFF power.Huawei: Alt 1-1-1-1.Apple: Alt 1-1-1-1; we prefer not to narrow the scope and to consider the original list RAN4 had agreed in R4-1913070 |
| Issue 1-1-2: Whether specialized test systems can be considered | Keysight: it is not very clear how a “specialized test system” is defined, e.g., is a specialized test system a currently not permitted system? We believe non-permitted test systems based on near field should be considered. MVG: Agree with KS. vivo: Alt 1-1-2-1, yes. We did not see very positive solutions on how to enhance the permitted test methods in TR 38.810 effectively to address the problematic TCs. From RF conformance testing perspective, even the permitted DFF and IFF can just cover part of the TCs, they are also “specialized system” permitted for whole FR2 RF conformance testing. Therefore, the study should initially focus on how to develop specialized test system to seek a reasonable solution for Objective 1 (i.e. other TCs).Samsung: “specialized test system” need to be clarified. If it means currently non-permitted method, we believe specialized test system can be considered; if it means test system only covering partial test cases, e.g. special test system not covering peak beam peak search and spherical coverage, how to obtain TX/RX beam peak direction for the special test system shall be further discussed, since most of TCs are based on TX/Rx beam peak direction.Qualcomm: Alt 1-1-2-1: YesFor regulatory compliance we may be forced to accept a dedicated TE that is not optimized for all tasks, but can tackle certain ones (like low PSD TRP measurements) better than current methods.MediaTek: TE solution for all TCs is still preferred.R&S: as mentioned in previous contributions, current methodologies has limited room for improvement for certain test cases, but some improvement can be achieved. Therefore, we agree with Apple’s proposal in R4-2009960 that 2 tracks should be considered to study the potential enhacements of current methodologies in parallel to alternate methods (or “specialized test system”).Sony: If a specialized test system means a system with limited scope that only fulfill the needs for specific requirements, then it should not be considered. It may increase the overall time and cost for test and development, and thus should be avoided.Keysight: The motivation for Topic 1 was to eliminate/reduce the relaxations for the low PSD test cases and we believe this should be the focus of the work of the enhanced test methodology. Requiring that same test system to perform the test cases that can be performed in existing test systems unnecessarily constrains the work to define enhanced test methodologies. Splitting this topic into two should be avoided given the delays we have experienced and the potentially added scope that might be added (47GHz testability and potentially others) Huawei: want to clarify on “specialized test system”.Apple: Alt 1-1-2-1; we would like to enable test methods which are not currently permitted in 38.810 (e.g. test system based on near field) and which might have applicability to a limited set of test cases. Given our preference for Alt 1-1-1-1 in the previous issue, we are interested in determining the parameters for a test system which addresses the requirements listed in R4-1913070 |
| Issue 1-1-3: Whether manufacturer declarations can be considered | Keysight: we believe declarations could be considered. However, we believe that white box testing which relies on vendors declaration on antenna locations is not helping to improve the relaxations when compared to existing black box testing. Since we believe RAN4 should focus on black box approach, no additional declarations are really necessary. MVG: Based on our simulations (presented and non-presented), we cannot conclude yet whether white box would help to improve relaxations. Declarations from vendors should be considered. Anyway, black box versus white box topic has been extensively discussed in RAN4 so we leave the ball to the manufacturers whether to go with either method.vivo: Alt 1-1-3-3. Before adopting “white box” approach to achieve further enhancement, we should study which information from UE declaration side is more valuable for the final target, in case some aspects may have limited improvement of the MU and test system capabilitySamsung: black box approach is highly preferred. White box could be considered when there shows obvious benefits. At least for beam peak search and spherical coverage test, white box approach has been discussed and is unaffordable. For other TCs based on single direction, the benefit of white box approach can be further discussed.MediaTek: Alt 1-1-3-3, although manufacturer declarations are not preferred.Sony: This is not our preference. We have concerns that adopting the white box approach may lead to an increased test time due to the UE repositioning.Keysight: Feedback to Apple “during this meeting we would like to come up with a list of potential candidate vendor declarations and how they map to a particular test system parameter”. We believe we addressed this in R4-1915080 for the white box approach (the black box approach does not require any):“It will furthermore determine the detail of the vendor declarations, e.g., if the enhanced test methodology just needs to perform the low UL power and high DL power testcases without performing beam peak searches, the vendor declaration can be limited to just the location of the active panels that yields the TX and RX beam peaks. If the enhanced test methodology needs to perform the beam peak searches as well, the declaration by the manufacturer must include which antenna panel is active in any UL/DL test direction and the detailed locations of the panels within the DUT”Huawei: Alt 1-1-3-3Apple: Alt 1-1-3-3; during this meeting we would like to come up with a list of potential candidate vendor declarations and how they map to a particular test system parameter. This way we can make a decision next meeting. |
| Issue 1-2-1: Whether a study on study on UE beam management sensitivity to magnitude/phase variation of the DL signal needed | Keysight: Yes but we would approach this topic differently (more below). MVG: We are open to further discuss simulation assumptions, if needed. vivo: for DNF system, we think this study is needed.Samsung: before answering this question, we need to make clear whether new developed test system shall cover beam peak search or not. If beam peak direction and UBF activation are performed based on FF method and then perform other TCs based on NF method, the beam management study seems not so necessary. Otherwise, the study is helpful.Qualcomm: The study, and techniques to minimize sensitivity, like using UBF, are important. Would phase magnitude sensitivity be a factor in TRP testing, if using UBF based on a far field antenna?MediaTek: It depends on whether there is specific TE that rely on the analysis or not.MVG: “Beam is formed toward the direction to where the DL signal is coming from (Beam Correspondence)”. Certainly, the mechanism works if the DL signal is a plane wave but even in this case a theoretical plane wave front would have 22.5deg phase variation at the DUT. This means that 22.5deg wouldn’t cause any issue in terms of pointing error (UL UE beam is aligned to the DL signal). What is the rationale behind this assumption? Why not 40deg phase curvature? There could be rea-life indoor scenarios where FF condition can not be met. How the UE beam management works in those scenarios? Apple: Alt 1-2-1-1; we would like to converge on simulation assumptions for this study during this meeting. |
| Issue 1-2-2: Simulation assumptions | Keysight: we believe the MVG/Sony assumptions need to be augmented and the focus should not just be the CDF curve around 50%-tile. The proposal is based on the 4x1 antenna array which was used for requirements definitions. Since this is a testability SI, we believe that the antenna assumptions should be based on the 8x2 antenna assumptions used for all the other PC3 testability work. The coordinate system in R4-2010856 seems to be different than what has been agreed for smartphones as well, e.g., top of UE is z in 3GPP but in this contribution x is used for top/bottom, etc.). Furthermore, the beam steering assumptions were not specified in the MVG/Sony contribution. To keep consistency with previous work, we believe similar/same beam steering assumptions as in G.3.1 of 38.810 should be leveraged. Using the assumptions of the contribution with a 4x1 antenna placed horizontally in the top right corner and beam steering assumptions with 22.5deg and 45deg granularity, a 7.5deg step size grid (leveraging the existing beam peak search grid) as well as NF antenna pattern assumptions and Matlab simulations similar to what was used for spherical coverage simulations for PC3, we get the following spherical coverage curves at a NF range length of 0.3m and in the FF (assumed 20m). While the CDF near and at 50% tile is similar, we can already see that the beam peak (max EIRP) is different.  When we change the simulation assumptions to an 8x2 antenna array placed vertically and re-used the assumptions (front and back antenna array, etc) from G.3.1 of 38.810 and assume an offset of 12.5cm in y (approaching the edge of the 30cm diameter QZ), we get the following CDF curve. Again, at 50%-tile, the NF and FF curves match but the beam peaks are different. We therefore do not agree with Observation 1 of R4-2010856Qualcomm: Does the pathloss analysis in MVG/Sony paper include TE antenna gain difference between FF and NF test setups? |
| MVG: Based on KS comments on antenna array orientation versus reference coordinate system, we would like to re do our simulation and see if any effect is captured. Thanks also KS for providing further simulation results. We think max EIRP delta, documented in first picture above is in line with what we have observed and documented in our contribution Table 2 (28GHz), and Table 4 (38GHz). Here the delta has been computed by comparing the directivity of each beam. Basically, we are dealing with radiation patterns so the normalization assumption is antenna efficiency (loss) has not been considered so that D(θ,φ)=G(θ,φ), and TRP=1 (0dBm) hence EIRP=TRP\* D(θ,φ)= D(θ,φ). We think our observation 1 in R4-2010826 is in line with the outcomes from KS simulations for the 4x1 linear array. 1dB delta on max EIRP can be considered a “small” delta when comparing to the whole MU for MOP.We are fine with simulating an 8x2 antenna array offset by 12.5cm on Y axis and see whether around 3dB delta observed by KS can be reproduced. On the other hand, we do encourage KS to repeat simulation when at 45cm for the 8x2 antenna array. We strongly think that the delta is increasing with the phase curvature of the spherical wave at the DUT. 30cm is probably a NF limit when testing 8x2 antenna array.MVG2: we have some comments about the above spherical coverage and specifically:1. It looks EIRP is better at 30cm than 20m. Typically, the gain in FF is better than the gain in FF. Any comments?
2. There are no clear differences between results for 4x1 and 8x2 antenna array. We would have expected to have better alignment between 30cm and 20m results for 4x1 antenna array than 8x2 antenna array. Any comments?

One more comment is about our results in R4-2010826. We don’t think orientation matters in our results since we take a fine step size (1deg per step). We think that for TR, it could be meaningful to have both 4x1 and 8x2 results since 4x1 array is mostly used in commercial smartphones. Samsung: we share similar view as MVG and vivo that 4x1 array shall be considered. 4x1 array is used in both peak EIRP requirement derivation and commercial devicesMVG: Yes, I can confirm there was a typo in our above comment. It should read: “Typically, the gain in **FF** is better than the gain in **NF”**. Yes, we can confirm that our simulations are for a 4x1 antenna array offset emulating a black box approach. Moreover, no path loss compensation has been applied (this should answer to the QCT comment too). From R4-2011218, it is not clear in which way path loss compensation is applied to NF power measurement. While NFtoFF transform is well-documented and widely used, we are waiting for KS to provide details about the transformation before concluding whether it works or not. Based on it, EIRP results look strange to us. Why the path loss compensation is not seen on the CDF curves? Those reported curves are in line with the curves we have shown (R4-2010826) for the 4x1 linear array caseWe do agree on considering different offsets but on the same time we believe that simulation results would be affected by antenna array pattern-DUT dependent.Sony: Similar view as Samsung, vivo and MVG, 4\*1 antenna array should be considered.Keysight (this feedback was provided earlier in a summary that was uploaded at the same time as vivo’s summary which was used as a baseline):Based on the above feedback, I believe that our analyses are likely not aligned. I was planning to introduce some our results and the underlying assumptions for our analyses in the next meeting. As I discussed earlier, in our tool, we are modeling the antenna patterns based on NF pattern assumptions (they converge to FF for large range lengths). Figure 18 of R4-2011218 shows the differences of the 8x2 pattern in the FF and NF (for an antenna centered at (0,0). The peak gain is slightly higher in the FF as in NF; is this what you were wondering about? I think you have a typo above in question #1 (“Typically, the gain in **FF** is better than the gain in **FF**. Any comments?”). Our analysis, however, does not stop at the antenna gain or directivity as we take into account the path loss the between the offset UE antenna array and the measurement probe and compensate the path loss between center of QZ and measurement probe; I believe you might not take the difference in path loss of the offset antenna into account if I look at your explanation above? Unless your analyses are for the white-box approach, we believe that this path loss difference is essential. This also explains why in the example presented here our peak EIRP for the NF case is higher than in FF as the peak was realized with the UE antenna array closer than 15cm from the measurement antenna. As you can see, we are assuming black box in our simulations. I should probably also point out that for every grid point, we try every antenna pattern available to the UE based on the codebook in G.3.1 of 38.810 and pick the beam that yields the best EIRP at the measurement probe. Regarding your second question/comment. The simulation assumptions for 4x1 and 8x2 cases are different, e.g., different offsets and different array orientations (I assumed vertical for 8x2 and my 4x1 assumed horizontal like you did in your contribution). However, our results showed better alignment between 30cm and 20m for 4x1 (max EIRP difference of ~1dB) when compared to 8x2 (~3.5dB). The CDF difference largely depend on the beam steering assumptions that were used and it is not clear what yours were. You asked to simulate the 45cm case which we compare below with the 20m FF case. As you can see, the peak EIRP with 45cm range length is closer to FF (when compared to 30cm range length).While I don’t oppose to simulate various cases, I think our simulations should consider different offsets (not just (9,12.5cm,0) rather than different antenna arrays. Since this is a testability SI, I think we should consider worst case (8x2) rather than status quo antenna assumptions. Keysight: This is a Rel-17 SI and limiting the analyses to common Rel-15 antenna architectures does not seem appropriate. However, we are not opposed to include 4x1 in the analyses but 8x2 should be considered to make decisions on enhanced testability methodologies and to compare preliminary MUs between existing test systems (analyzed based on 8x2) and the enhanced test methodology. Comment to MVG questions:MVG:“While NFtoFF transform is well-documented and widely used, we are waiting for KS to provide details about the transformation before concluding whether it works or not.”Our CDF analyses are based on DNF, i.e., no transformations were used. I place the UE in the center of the QZ, rotate the UE to the desired test point, introduce the DL from this direction at either NF or FF, let the UE decide which beam from the available codebook results in the best EIRP which is then used for the CDF. MVG: “Based on it, EIRP results look strange to us. Why the path loss compensation is not seen on the CDF curves?”The path loss compensation is not fixed as it varies for each test point. For some test points, the antenna array is closer than the range length from the measurement antenna and for other test points, the antenna array is further away than the range length from the measurement antenna. It’s therefore averaged out essentially. Huawei: 8\*2 simulation assumption is not coming from which antenna array implementation is commercialized. Whether 4\*1 need to be assumed do not depend on commercial usage. It depends on whether the antenna array scale can cover most antenna factors of UEs.Apple: We should use the same antenna array assumptions as in Rel-15, because the outcome of the study will also be important for the calculation of the measurement uncertainty contribution. These assumptions were captured in [R4-1808410](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_87/Docs/R4-1808410.zip) (i.e. an 8x2 patch array). Results for the 4x1 array can be useful to consider as well, but 3GPP shall use the 8x2 array results to inform decisions on measurement uncertainty and test tolerance aspects. |
| Issue 1-3-1: Whether RAN4 can reach a common understanding on the path loss comparison across IFF/DFF and NF system types | Anritsu: Not clear the intention of this sub-topic but we observed a slight difference in a range of 0.02 dB to 0.16dB. I guess the difference is coming just from the rounded range length (such as 0.28m is 0.275m indeed.)vivo: prefer Alt 1-3-1-2. If white box can be adopted, the antenna size of D=5cm may be further decreased. In addition, more important thing is the final power analysis of the whole system with proper parameters of components (cable length, amplifiers, new switching box with better performance for partial TCs, etc.,), but not only free space path loss comparison.In addition, we share similar view with MVG on antenna assumptions. Several papers had been submitted in previous RAN4 meeting from companies to change 8x2 antenna to 4x1 which is commonly used for FR2 UEs. We think that 8x2 was initially assumed for simulation of measurement grid and system measurement uncertainty in TR38.810. For this enhanced method study, we suggest to adopt more typical assumptions like 4x1 to reflect the analysis close to real condition.Samsung: this important for decision of white box approach. If companies have different understanding, further check is needed; if companies have the common understanding as Alt 1-3-1-1, there seems low chance for white box approach for consideration.R&S: in line with vivo’s comment, the table presented R4-2011218 is a good comparison of the Free Space Path Loss between different options, but the whole system path loss is not included in this study. Changes in cables, switching, antenna gain, etc. are most probably required when comparing an IFF system to a NF system, so the actual gain between methods is not as large as shown in the table.Keysight: Comment to R&S. We agree that the end-to-end system performance needs to be considered but the free-space losses are the dominating reason for why the relaxations are needed. It is not clear why a test system with measurements performed in NF, limited to In-Band/OOB, and that is limited to low PSD test cases has higher end-to-end losses. Huawei: Alt 1-3-1-2Apple: We would like to take Alt 1-3-1-1 as a starting point during this meeting with the view toward further refinement based on additional analysis by companies next meeting. To R&S comment, if we consider a specialized test system for the low PSD test cases, then the insertion losses due to cables and switches can also be optimized. |

### 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** |
| R4-2011218(Keysight) | Anritsu: Though 1218 is not a CR, I would like to take a freedom to use this area to leave a comments and questions. To be sure, we are not against studying the NF measurement approach though we are skeptic with the benefit of NF measurement.On Proposal 2: It is difficult to understand the idea of the effective antenna aperture. The actual antenna aperture size cannot change on the UE depending on the frequency. Only the possible way to calculate the range length should be based on the vendor declaration of aperture size. **Keysight: the key idea here is that MxN antenna arrays at 40GHz are smaller than MxN antenna arrays at 24GHz due to the common lambda/2 inter-element spacing. Currently, we are assuming them to have the same antenna aperture which we believe is incorrect.** On NF testing with a transform: Since there is no detailed procedure, if possible could you tell the following questions?Q1: Does the measured signal need to be CW or modulated? If we measure by modulated waveform, we imagine that the measurement is utilizing the RS which is included in the UL signals and monitoring a phase change. Then we assume that another probe antenna to provide the phase reference. **Keysight: the measured signal can be a modulated signal and does not have to be CW. No phase references/ measurements are needed**On TRP testing in the NF: When we looked at Figure 21, we had a question why the histogram of the TRPs without correction are spread to the direction which is larger than the reference TRP. We imagined the reason why the uncertainties of TRP of NF measurement without transform is large is coming from the lack of calibration with probe antenna directivity. But if it is the error factor, the error should spread to the direction of smaller TRP value.**Keysight: for an offset antenna, the reduced distance between antenna and measurement antenna can yield higher EIRPs and thus higher TRP.** Do you have any idea on the method to measure EIS? When we measure EIRP we can rotate the DUT and change the probe antenna direction. However when we measure EIS, we suppose multiple probe antennas are necessary to create the magnetic field at the UE side which is equivalent to the DL beam from far-field.**Keysight: the measurement setup is the same as for EIRP. Again, no phase measurements are needed**Generally speaking, reference antenna gain is guaranteed only by far field. If we measure the absolute power at near field, do you think that we need to calibrate antenna gain specially at the near field measurement distance?  |
| 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**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| Issue 1-1-1: Whether the scope of the impacted high DL power and low UL power test cases can be further narrowed | *Agreement:*According to WF in R4-1913070 (no change from prior agreement) |
| Issue 1-1-2: Whether specialized test systems can be considered | *Candidate options:*Alt 1-1-2-1: Yes vivo, Qualcomm, Keysight, Apple (4)Alt 1-1-2-2: No MediaTek, Sony (2)(new) Alt 1-1-2-3: non-permitted test systems based on near field should be considered Keysight, MVG (2)(new) Alt 1-1-2-4: non-permitted test systems, assuming they are capable of beam peak search and spherical coverage evaluation Samsung (1)(new) Alt 1-1-2-5: Progress the work on the high DL power / low UL power objective in two tracks: one examining possible enhancements to the permitted test methods listed in TR38.810 and another focusing on alternative methods R&S, Apple (2)*Recommendations for 2nd round:*There appears to be broad support (5 companies) to investigate non-permitted test systems. Based on the outcome of Issue 1-1-1, the scope of test applicability of these test systems under investigations is according to WF in R4-1913070. One company further prefers these test systems under investigation should be capable of beam peak search and spherical coverage evaluation.On the other hand, 2 companies prefer not to investigate non-permitted test systems with limited scope, and 2 other companies prefer to progress in two tracks: one examining possible enhancements to the permitted test methods listed in TR38.810 and another focusing on alternative methods (we note that according to the WF in R4-1913070 it is already agreed to progress the work in two tracks).Based on the above observations, it is recommended to focus the Round 2 discussions on the following proposals:Proposal 1-1-2a: Investigate non-permitted test systems, such that the test case applicability of these test systems under investigations is according to WF in R4-1913070 (i.e. such test systems are not required to verify all requirements in TS38.101-2).Proposal 1-1-2b: Whether non-permitted test systems under investigation shall be capable of beam peak search and spherical coverage evaluation is FFS.Proposal 1-1-2c: Since no new candidate non-permitted systems have been proposed since the WF in R4-1913070, the list of candidate non-permitted test systems is limited to NFTF and DNF solutions.Proposal 1-1-2d: For non-permitted test systems under investigation, text proposals on test setup descriptions, gains from the enhancements relative to permitted methods in TR38.810, impact on test time, and preliminary MU are needed for the next RAN4 meeting.Proposal 1-1-2e: For the permitted methods in TR38.810, text proposals on test setup descriptions, gains from the enhancements relative to permitted methods in TR38.810, impact on test time, and preliminary MU are needed for the next RAN4 meeting. If no such proposals are submitted by the next RAN4 meeting, then RAN4 agress that no enhancement of permitted methods is feasible. |
| Issue 1-1-3: Whether manufacturer declarations can be considered | *Candidate options:*Alt 1-1-3-1: Yes (0)Alt 1-1-3-2: No Keysight, Sony (2)Alt 1-1-3-3: further study which detailed information from the vendor declaration is necessary should be discussed and decided vivo, MediaTek, Huawei, Apple (4)(new) Alt 1-1-3-4: For TCs based on single direction, the benefit of white box approach can be further discussed Samsung (1)*Recommendations for 2nd round:*It appears that at least 5 companies are open to further study the potential benefit of vendor declarations to improve the relaxations.Proposal 1-1-3a: The list of potential candidate vendor declarations and how they map to a particular test system parameter includes the following:- Location of the active panels that yields the TX and RX beam peaks (applicable if the enhanced test methodology does not need to perform beam peak search)- 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)Proposal 1-1-3b: Whether vendor declarations can be restricted to TCs based on single direction is FFS (to be determined next RAN4 meeting);Proposal 1-1-3c: Whether vendor declarations, based on Proposals 1-1-3a and 1-1-3b, can be adopted as methodology enhancements is FFS (to be determined next RAN4 meeting) |
| Issue 1-2-1: Whether a study on study on UE beam management sensitivity to magnitude/phase variation of the DL signal needed | *Candidate options:*Alt 1-2-1-1: Yes Keysight, MVG, Apple (3)Alt 1-2-1-2: No (0)(new) Alt 1-2-1-3: Yes for DNF system vivo (1)(new) Alt 1-2-1-4: If beam peak direction and UBF activation are performed based on FF method and then perform other TCs based on NF method, the beam management study seems not so necessary. Otherwise, the study is helpful Samsung (1)*Recommendations for 2nd round:*Five companies have expressed a preference for some type of a study of beam management sensitivity. Based on the observation by Samsung related to beam peak search capability, and since this issue is still open (see Proposal 1-1-2b), it seems Proposal 1-2-1a: If beam peak direction and UBF activation are performed based on FF method and then perform other TCs based on NF method, then the beam management study is not necessary.Proposal 1-2-1b: For the DNF system, and assuming it needs to perform beam peak search, such that the DUT is enabled to form its UL beam in the direction of the DL signal, a study of UE beam management sensitivity to magnitude/phase variation of the DL signal needed. |
| Issue 1-2-2: Simulation assumptions | *Recommendations for 2nd round:*It is recommended to allocate a new tdoc to MVG and Keysight in order to align the simulation assumptions to address Proposal 1-2-1b.  |
| Issue 1-3-1: Whether RAN4 can reach a common understanding on the path loss comparison across IFF/DFF and NF system types | *Candidate options:*Alt 1-3-1-1: According to R4-2011218 Samsung, Apple (2)Alt 1-3-1-2: Further study is needed vivo, Huawei (2)*Recommendations for 2nd round:*Proposal 1-3-1a: The path loss comparison across IFF/DFF and NF system types below is taken as a starting point, and companies are encouraged to bring proposals to the next RAN4 meeting with corrections and/or improvements:

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| --- | --- | --- |
| ***f* [GHz]** | **Antenna Config. 1, 2, and 3- BLACK BOX -** **(PC3 Devices: D=5cm)** | **Antenna Config. 1 and 2- WHITE BOX - (PC3 Devices: D=5cm)** |
| **IFF/DFF** | **NF** | **DFF** | **NF** |
| **Path Loss with 1m range length** | **Path Loss with 0.22m range length** | **Path Loss with 0.88m range length** | **Path Loss with 0.28m range length** |
| **24.25** | 60.16 | 46.86 | 59.01 | 48.93 |
| **30** | 62.01 | 48.71 | 60.85 | 50.78 |
| **40** | 64.51 | 51.21 | 63.35 | 53.28 |
| **43.5** | 65.24 | 51.94 | 64.08 | 54.00 |
| **52.6** | 66.89 | 53.59 | 65.73 | 55.65 |

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*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on the high DL power and low UL power test cases objective | Apple |

### 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”* |

## Discussion on 2nd round (if applicable)

Issue 1-1-2: Whether specialized test systems can be considered

Proposal 1-1-2a: Investigate non-permitted test systems, such that the test case applicability of these test systems under investigations is according to WF in R4-1913070 (i.e. such test systems are not required to verify all requirements in TS38.101-2).

Proposal 1-1-2b: Whether non-permitted test systems under investigation shall be capable of beam peak search and spherical coverage evaluation is FFS.

Proposal 1-1-2c: Since no new candidate non-permitted systems have been proposed since the WF in R4-1913070, the list of candidate non-permitted test systems is limited to NFTF and DNF solutions.

Proposal 1-1-2d: For non-permitted test systems under investigation, text proposals on test setup descriptions, gains from the enhancements relative to permitted methods in TR38.810, impact on test time, and preliminary MU are needed for the next RAN4 meeting.

Proposal 1-1-2e: For the permitted methods in TR38.810, text proposals on test setup descriptions, gains from the enhancements relative to permitted methods in TR38.810, impact on test time, and preliminary MU are needed for the next RAN4 meeting. If no such proposals are submitted by the next RAN4 meeting, then RAN4 agress that no enhancement of permitted methods is feasible.

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| **Company** | **Comments** |
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Issue 1-1-3: Whether manufacturer declarations can be considered

Proposal 1-1-3a: The list of potential candidate vendor declarations and how they map to a particular test system parameter includes the following:

- Location of the active panels that yields the TX and RX beam peaks (applicable if the enhanced test methodology does not need to perform beam peak search)

- 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)

Proposal 1-1-3b: Whether vendor declarations can be restricted to TCs based on single direction is FFS (to be determined next RAN4 meeting);

Proposal 1-1-3c: Whether vendor declarations, based on Proposals 1-1-3a and 1-1-3b, can be adopted as methodology enhancements is FFS (to be determined next RAN4 meeting)

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| **Company** | **Comments** |
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Issue 1-2-1: Whether a study on study on UE beam management sensitivity to magnitude/phase variation of the DL signal needed

Proposal 1-2-1a: If beam peak direction and UBF activation are performed based on FF method and then perform other TCs based on NF method, then the beam management study is not necessary.

Proposal 1-2-1b: For the DNF system, and assuming it needs to perform beam peak search, such that the DUT is enabled to form its UL beam in the direction of the DL signal, a study of UE beam management sensitivity to magnitude/phase variation of the DL signal needed.

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| **Company** | **Comments** |
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Issue 1-3-1: Whether RAN4 can reach a common understanding on the path loss comparison across IFF/DFF and NF system types

Proposal 1-3-1a: The path loss comparison across IFF/DFF and NF system types below is taken as a starting point, and companies are encouraged to bring proposals to the next RAN4 meeting with corrections and/or improvements:

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| --- | --- | --- |
| ***f* [GHz]** | **Antenna Config. 1, 2, and 3- BLACK BOX -** **(PC3 Devices: D=5cm)** | **Antenna Config. 1 and 2- WHITE BOX - (PC3 Devices: D=5cm)** |
| **IFF/DFF** | **NF** | **DFF** | **NF** |
| **Path Loss with 1m range length** | **Path Loss with 0.22m range length** | **Path Loss with 0.88m range length** | **Path Loss with 0.28m range length** |
| **24.25** | 60.16 | 46.86 | 59.01 | 48.93 |
| **30** | 62.01 | 48.71 | 60.85 | 50.78 |
| **40** | 64.51 | 51.21 | 63.35 | 53.28 |
| **43.5** | 65.24 | 51.94 | 64.08 | 54.00 |
| **52.6** | 66.89 | 53.59 | 65.73 | 55.65 |

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| **Company** | **Comments** |
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WF on the high DL power and low UL power test cases objective (Apple)

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| **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*

|  |  |
| --- | --- |
| **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 #2: Polarization mismatch

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2009627](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2009627.zip) | MediaTek Inc. | **Views on FR2 SISO EIRP test enhancement**Proposal 1: 2-port CSI-RS shall be provided in EIRP test procedure.Proposal 2: 2-port CSI-RS can be simultaneous or sequent.Proposal 3: Practical TPMI shall be provided in EIRP test procedure. |
| [R4-2009961](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2009961.zip) | Apple Inc. | **Views on the polarization mismatch objective**Proposal 1: RAN4 should identify a list of possible test methodology enhnacement techniques to address the issues identified with the EIRP measurement in the presence of polarization basis mismatch between the DUT and the test equipment.Proposal 2: For UEs which exhibit the impact of polarization mismatch on EIRP measurement, it can be useful to quantify the impact on MU when measured according to the permitted methods in TR38.810 and to evaluate the tradeoff between test time and MU improvement as a function of polarization angles used in the sweeping approach.Proposal 3: RAN4 should strive to enhance the FR2 RF test methodology to remove the necessity of using a UE test mode. |
| [R4-2010129](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2010129.zip) | LG Electronics | **EIRP measurement for polarization mismatch**Observation 1: A UE capable of 2Tx transmission may trigger only one polarization due to the polarization mismatch.Observation 2: Whenever the UE triggers only one polarization for transmission, the equation of EIRP does not include UEâ€™s polarization gain.Observation 3: UEâ€™s polarization gain has been assumed when RAN4 defined the EIRP requirements such as min. peak EIRP and EIRP spherical coverage.Observation 4: In RAN4#93 meeting, eight possible test methodologies techniques for enhancement have been captured to minimize or remove the polarization mismatch.Observation 5: Based on the result of the informal email discussion, six companies identify that there is a potential conflict between the core requirement and the current EIRP measurement procedure. However, four companies does not find the conflict.Observation 6: Using TPMI can be a good solution to trigger 2Tx transmission for Rel-16 UEs in order to avoid the UEâ€™s behaviour such as triggering only one polarization for transmission.Observation 7: The solution of using TPMI is only available to Rel-16 UEs since it is not allowed to use TPMI of [] to force Rel-15 UEs to trigger 2Tx transmission [6].Observation 8: Based on the observation 7, the total EIRP does not include the polarization gain when Rel-15 UEs may trigger only one polarization due to the polarization mismatch.Observation 9: Introducing the polarization scan method can be beneficial to minimize the polarization mismatch between the TE and Rel-15 UE. However, this test method will increase test times by a factor of N (# of scanning sector). If N is not chosen carefully, then the test times will be increased significantly.Proposal 1: For Rel-16 UE, RAN4 should use TPMI of [] to force UE to trigger 2Tx transmission for the EIRP measurement.Proposal 2: For Rel-15 UE, RAN4 should use the following equation for the EIRP measurement.Proposal 3: For Rel-15 UE, RAN4 should also use the TPMI of] and] to force UE to trigger one polarization for the EIPR measurement.Proposal 4: The polarization scan method should be an optional test methodology technique for Rel-15 UEs. These Rel-15 UEs can report N (# of polarization scan) to let the TE inform that it can support the polarization scan method. |
| [R4-2010202](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2010202.zip) | Samsung | **Discussion on dual polarization transmission for UL TX test**Observation 1: there is fundamental conflict between core requirement and EIRP measurement procedure. Core requirement is based on simultaneous 2TX but EIRP measurement procedure can not robustly enable 2TX.Observation 2: current EIRP test method in TR 38.810 can correctly capture the power from UE. The remaining issue if how to enable simultaneous 2TX for 1 layer transmission with DFT-s-OFDM waveform.Observation 3: Even UE supports UL full power transmission mode1, TMPI solution to enable 2TX transmission is not feasible for MOP requirements in clause 6.2 of TS 38.102-2 where nrofSRS-Ports = 1.Observation 4: a method is needed to activate TX Diversity for UE under test.Observation 5: FR2 EVM test is also feasible under TX Diversity mode as long as it is just dual polarization transmission with exactly the same signals without delay.Proposal 1: focus on test methods which are reliable and easy to trigger 2TX transmission to align with EIRP core requirement.Proposal 2: RAN4 study TX Diversity and/or Test Mode to be applied in EIRP measurement.Proposal 3: UE side TX Diversity transmission (dual polarization transmission) is triggered by Test Equipment, which is a test mode to address polarization gain and also applicable for EVM measurement. |
| [R4-2011217](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2011217.zip) | Keysight Technologies | **On minimizing the impact of polarization basis mismatch between the TE and DUT on the RF testing**Observation 1: For coherent UEs, both Rel-15 and Rel-16 allow a TPMI to be used that forces single-layer transmission using two antenna ports.Observation 2: For non-coherent UEs, Rel-15 does not allow a TPMI to be used that forces single-layer transmission using two antenna ports.Observation 3: For non-coherent UEs, Rel-16 allows a TPMI to be used that forces single-layer transmission using two antenna ports with the newly introduced ul-FullPowerTransmission = fullpowerMode1 mode.Observation 4: OEMs to comment whether RAN1â€™s definition of TPMI indices 2-5 forcing single-layer transmission using two antenna ports corresponds to the UE enabling two transmit chains at all timesProposal []:Proposal 1: RAN4 to focus on the polarization scan which can reliably force the UE to simultaneously transmit on both transmit chain/antennas in order to minimize the impact of polarization basis mismatch between the TE and DUT. |
| [R4-2011423](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2011423.zip) | Sony, Ericsson | **Views on testability enhancement for UE FR2 test**Observation 1: RAN4 has made an agreement that UE shall support two receivers with rank 1 reception for REFSENS.Observation 2: The current test method can capture the UE transmitted power correctly, and how a UE uses one or more Tx chains to transmit is an implementation issue.Observation 3: The mapping between digital ports and RF ports can be flexible in the implementation.Observation 4: The non-coherent UEs cannot transmit over two TXs with rank 1 transmission.Observation 5: The codebook-based transmission is typically used when the uplink/downlink reciprocity does not hold, which may be against the principle of beam correspondence test.Observation 6: The power-up command in MOP tests can ensure the UE uses all the TXs it has.Observation []: The power-up command in MOP tests can ensure the UE use all the TXs it has.Proposal 1: The current EIS metric is feasible to be applied to different UE RF implementations, and shall be kept without any modification.Proposal 2: If the EIS test metric would be modified, the new metric shall be able to distinguish between different performing UEs and take the test time into account.Proposal 3: The current EIRP test is feasible to be applied to different UE RF implementations, and shall be kept without any modification.Proposal []: If EIS test metric would be modified, the new metric shall be able to distinguish between different performing UEs and take the test time into account. |
| [R4-2011457](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2011457.zip) | Qualcomm Incorporated | **FR2 testability enhancement for polarization mismatch**Observation 1: ULFPTx feature does not guarantee dual pol transmitObservation 2: ULFPTx is useful for Rel-16 UEs to allow compliance with EIRP requirements even when the UE is configured for multiple SRS ports and transmission on a single layer.Proposal 1: If new DL polarization conditions are introduced for compliance testing in addition to those already captured by TS38.521-2 v16.4, the UE must additionally demonstrate compliance with each of the new DL polarization conditions.Proposal 2: FR2 TE topology shall be enhanced by adopting dual polarization coherent receivers. |

## 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: FR2 EIRP SISO test enhancement

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1: Whether TPMI side conditions are feasible to introduce to the test setup**

* Proposals
	+ Alt 2-1-1-1: Yes
	+ Alt 2-1-1-2: No
	+ Alt 2-1-1-3: Further study is needed, including other options

**Issue 2-1-2: How to define TPMI side conditions**

* Proposals
	+ Alt 2-1-2-1: Practical TPMI shall be provided in EIRP test procedure
	+ Alt 2-1-2-2: For Rel-16 UE, RAN4 should use TPMI of [$\begin{matrix}1\\1\end{matrix}$] to force UE to trigger 2Tx transmission for the EIRP measurement, and for Rel-15 UE, RAN4 should also use the TPMI of$ [\begin{matrix}1\\0\end{matrix}$] and$ [\begin{matrix}0\\1\end{matrix}$] to force UE to trigger one polarization for the EIPR measurement.
	+ Alt 2-1-2-3: Further study is needed

**Issue 2-1-3: Whether and, if feasible, how to modify the definition of the total EIRP calculation**

* Proposals
	+ Alt 2-1-3-1: According to R4-2010129:
	+ EIRP (PolLink=θ) = EIRP (PolLink=θTPMI0) + EIRP (PolLink=θTPMI1)
	+ EIRP (PolLink=φ) = EIRP (PolLink= φ TPMI0) + EIRP (PolLink= φ TPMI1)
	+ The total component of EIRP for Rel-15 UEs = max (EIRP (PolLink=θ), EIRP (PolLink=φ))
	+ Alt 2-1-3-2: No
	+ Alt 2-1-3-3: Further study is needed

**Issue 2-1-4: Whether polarization scan method is feasible**

* Proposals
	+ Alt 2-1-4-1: Yes
	+ Alt 2-1-4-2: Yes, for Rel-15 only and as an optional technique [according to R4-2010129]
	+ Alt 2-1-4-3: Adopt method 0 (current procedure in TR 38.810) as basis for EIRP testing, any potential enhanced procedure (e.g. method 1, 5, and 7) can be allowed for testing as optional for specific UE implementation based on UE declaration [according to R4-2011236]
	+ Alt 2-1-4-3 No

**Issue 2-1-5: Whether a test mode to trigger TX diversity is sufficient and feasible**

* Proposals
	+ Alt 2-1-5-1: Yes
	+ Alt 2-1-5-2: No

**Issue 2-1-6: Whether a power up command to trigger TX diversity is sufficient and feasible**

* Proposals
	+ Alt 2-1-6-1: Yes
	+ Alt 2-1-6-2: No

**Issue 2-1-7: Whether 2-port CSI-RS is feasible to introduce to the test setup**

* Proposals
	+ Alt 2-1-7-1: Yes
	+ Alt 2-1-7-2: No

**Issue 2-1-8: 2-port CSI-RS shall be simultaneous or sequential**

* Proposals
	+ Alt 2-1-8-1: simultaneous
	+ Alt 2-1-8-2: sequential
	+ Alt 2-1-8-3: both are allowed

### Sub-topic 2-2: Demodulation of UL by test equipment

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: Whether FR2 test equipment topology shall be enhanced by adopting dual polarization coherent receivers**

* Proposals
	+ Alt 2-2-1-1: Yes
	+ Alt 2-2-1-2: No
	+ Alt 2-2-1-3: Further study is needed

## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company Comments** |
| Issue 2-1-1: Whether TPMI side conditions are feasible to introduce to the test setup | Keysight: No (as outlined in R4-2011217)vivo: TPMI can only be applied for partial UEs to transmit 1 layer with two antenna ports. Not so sure if we need to separate the discussions to TPMI for Rel-15 UE and Rel-16 UE.Samsung: generally speaking TPMI is a good way as long as UE support 2TX TPMI [1,1]T , however, Rel-15 UE and some Rel-16 UE does not support 2TX TPMI. Moreover, if MOP is tested with nrofSRS-Ports = 1, TPMI solution is not feasible. (refer to detailed analysis in R4-2010202)Qualcomm: Alt 2-1-1-1MediaTek: Alt 2-1-1-1 (Yes)LGE: need to further check for using TPMI [1 1]R&S: Alt 2-1-1-1.Sony: First of all, we think there is no testability issue for BC test as we have explained many times: the UE transmitted power is correctly captured by the TE, and whether transmit with 1 Tx or 2 Txs is a UE implementation choice. However, if majority view is for FFS on TPMI, we are open to that as well. To our understanding, the TPMI cannot fully resolve the issue of 1 Tx or 2 Tx, especially for noncoherent UEs. In addition, the codebook-based transmission is typically used when the uplink/downlink reciprocity does not hold, which seems against the principle of beam correspondence test. In the BC test, the UE should autonomously decide which digital port to use based on the DL measurement. Huawei: No. Rel-15 UE do not support. Rel-16 UE depends on UE capability.Apple: Alt 2-1-1-2. It seems to us that the TPMI solution might be better suited to the testability of FR2 UEs implementing Tx diversity according to the Rel-16 requirements. We suggest checking whether a core requirement exists which needs this testability solution. If this is the case, then the SID can be updated to include this as an objective. For UEs which are tested for maximum output power with single port transmission, this approach is not applicable. Thus, strictly speaking, this approach is not applicable to the FR2 EIRP SISO test enhancement objective, but it could be applicable to the SI as another objective, if there is a need from the core requirement perspective. |
| Issue 2-1-2: How to define TPMI side conditions | Keysight: further study is needed, i.e., feedback from OEMs is needed whether RAN1’s definition of TPMI indices 2-5 forcing single-layer transmission using two antenna ports corresponds to the UE enabling two transmit chains at all times (Observation 4 from R4-2011217)vivo: this is based on the decision on Issue 2-1-1.Qualcomm: Alt 2-1-2-1our proposed CR R4-2011450 shows one implementation for introducing TPMI specification into UE configuration. Note however that Rel-15 behavior must be supported also, where ULFPTx is not availableMediaTek: Support Alt 2-1-2-1 (Practical TPMI shall be provided in EIRP test procedure). Please note that, if TE uses dummy TPMI and separate the test to two steps, it is possibly that UE may not really follow the TPMI, and lead the EIRP be double-counted.LGE: Alt 2-1-2-2. Using TPMI of$ [\begin{matrix}1\\0\end{matrix}$] and$ [\begin{matrix}0\\1\end{matrix}$] can be considered to trigger one polarization at a time and the modified total EIRP equation in R4-2010129 can be used to achieve the diversity gain for the EIRP measurement. We are also open to discuss about other possible options.R&S: Alt 2-1-2-3 (further study). Any proposal related to a practical TPMI should be further studied and very carefully defined since it will imply major changes in current TE methodology, which is based on sequential transmission over the TE antenna polarizations. Sony: Further study is neededHuawei: Alt 2-1-2-3: Further study is neededApple: Alt 2-1-2-3 (further study) |
| Issue 2-1-3: Whether and, if feasible, how to modify the definition of the total EIRP calculation | Keysight: novivo: no. regarding Rel-15 EIRP calculation and test procedure, we do not think there is a mismatch. if further procedure is updated, potential new calculation approach can be discussed.Samsung: current EIRP calculation correctly captures the power of UE transmitted. We need to focus on how to enable 2TX transmission and then perform EIRP test based on current EIRP calculation.Qualcomm: Alt 2-1-3-2: NoWe do not favor constructing a new EIRP composite from measured EIRPs over multiple DL conditions or multiple different UE configurations (TPMIs) because it is not physical, and questions remain about the equivalence of any composite metric to live operationMediaTek: Alt 2-1-3-2 (No). Similar comment in “Issue 2-1-2”, if TE uses dummy TPMI and separate the test to two steps, it is possibly that UE may not really follow the TPMI, and lead the EIRP be double-counted.LGE: The current EIRP measurement method cannot have the diversity gain if a UE triggers only one polarization due to the polarization mismatch and Alt 2-1-3-1 could address the issue.Sony: No. The EIRP metric needs to be physically meaningful in the first place. The current EIRP definition is technically correct and should not be changed.Huawei: No.Apple: 2-1-3-2 (no) |
| Issue 2-1-4: Whether polarization scan method is feasible | Keysight: Alt 2-1-4-1: Yes (for Rel-15 and whether beyond Rel-15 is TBD)Anritsu: Alt 2-1-4-4: To be studied further. Just to make sure, this polarization scan method is only to enable UE to transmit UL signals from both polarizations and not for the EVM measurement, isn’t it?vivo: potential enhanced procedure with polarization scan can be adopted as alternative which can be selected for conformance testing in RAN5 based on UE declaration. Samsung: Alt 2-1-4-3 No. TE&UE polarization mismatch does not affect test result. 2Tx should be enabled by other way. Even TE and UE polarization finally match after polarization scan, it can not enable 2Tx for Rel-16 UE and some Rel-16 UE.Qualcomm: Alt 2-1-4-4 No The gNB does not have the luxury of polling each UE at every instant for optimal DL polarization to tease out best UL power. In the context of EIRP measurement then, the DL pol-scan method represents further separation from real deployment conditions. It is therefore not feasible as a replacement for the existing method (‘link pol’ is first along theta, then phi) of capturing EIRP. We however appreciate the TE community aggressively pursuing solutions in FR2LGE: Alt 2-1-4-2. The polarization scan method would be feasible, but RAN4 should be careful about increasing overall test time.R&S: Alt 2-1-4-3 (No). We agree with Samsung’s and Qualcomm’s comments. Polarization scan will increase prohibitively the test time and has not correspondence with field conditions.Sony: No. The test time shall always be taken into account when we discuss any potential enchantment. Also share the similar view as QC that the DL pol-scan method make the test to be further away from real deployment conditions. Huawei: Alt 2-1-4-2.Apple: Alt 2-1-4-1 (yes) |
| Issue 2-1-5: Whether a test mode to trigger TX diversity is sufficient and feasible | vivo: we are supportive to develop test mode to address this issue.Samsung: Alt 2-1-5-1: Yes. We share similar view with vivo. Test mode to enable TX diversity is the most efficient and reliable way.Qualcomm: Alt 2-1-5-2: No Test modes are not appropriate for compliance but we must rely on it when there is a TE short coming. In this instance, however, we do not have a TE problem with measuring EIRP. If a UE does not fire in both polarizations, and the TE captures that behavior, it is representative of UE behavior in the field.MediaTek: Alt 2-1-5-2: NoLGE: need to further check for using a test mode to trigger Tx diversityAnritsu: Alt 2-1-5-2: No. Share the same view with Qualcomm.Sony: No. Huawei: Yes, we support to develop.Apple: Alt 2-1-5-2 (no) |
| Issue 2-1-6: Whether a power up command to trigger TX diversity is sufficient and feasible | vivo: we are not clear how the power-up command can operate TxD mode properly. Further clarifications is needed.Samsung: it is difficult to understand that TX diversity can be triggered by power up command. In current test procedure, power up command is already adopted, but there is polarization gain issue, Qualcomm: Alt 2-1-6-2: NoMediaTek: Alt 2-1-6-2 (No). Power-up command can trigger UE TX diversity but not sufficient for providing the optimum diversity gain.LGE: need to further check for using power up command for testingSony: Yes, to our understanding. We think with the power-up command, the UE should eventually use all the Tx power it has to reach the maximum output power, and it should work with all type of UEs.Huawei: need further check. It seems depend on implementation.Apple: Alt 2-1-6-2 (no); according to our understanding, RAN5 already uses power up commands for MOP testing, and the issue has been identified in the presence of this test procedure. |
| Issue 2-1-7: Whether 2-port CSI-RS is feasible to introduce to the test setup | Samsung: in our understanding, even 2-port CSI-RS is configured, Rel-15 UE and some Rel-16 UE can not support 2TX transmission. Besides, for beam correspondence based on SSB, CSI-RS is not provided.Qualcomm: Alt 2-1-7-1: Yes (qualified)We do not think 2-port CSIRS would suddenly trigger twin-pol UL due to some standards mandated UE behavior. Now, this behavior may indeed manifest in some UE implementations, so we would like to understand more about the reasons, and whether the mechanism applies more generally.In our view, a 2 port P3 CSIRS enables the UE to make a better judgment of its beam choice especially for rank 2, see R4-1910767, so there is some relevance to deployments, although not for DL SISO. Twin pol transmit from the TE also brings the TE that much closer to deployment even for SISO condition, although some study is required to examine this avenue in more detail. 2-port CSIRS becomes feasible if TE adopts dual port transmit. This development can go hand in hand with development of the OTA-rated twin coherently-combined receiver in the TE. MediaTek: Alt 2-1-7-1 (Yes). To Samsung and Qualcomm: Yes, 2-port CSI-RS cannot replace practical TPMI. Hence, we think TE shall provide practical TPMI to trigger two polarizations, and also provide 2-port CSI-RS to “enables the UE to make a better judgment of its beam choice” as Qualcomm’s insight.R&S: Further clarification is needed on the CSI-RS configuration and DL signal configuration. Would it be required to transmit on both DL polarizations at the same time? This is heavily related to the practical TPMI on Issue 2-1-2, and thus the same comments are also applicable. Sony: Similar view as R&S. further clarification is needed.  |
| Issue 2-1-8: 2-port CSI-RS shall be simultaneous or sequential | MediaTek: Alt 2-1-8-3 (both are allowed). However, Alt 2-1-8-1 (simultaneous) would be further beneficial on test time.R&S: This is heavily related to the practical TPMI on Issue 2-1-2, and thus the same comments are also applicable. Simultaneous 2-port CSI-RS implies a major change in current approach. |
| Issue 2-2-1: Whether FR2 test equipment topology shall be enhanced by adopting dual polarization coherent receivers | Keysight: Alt 2-2-1-3: Further study is neededAnritsu: Alt2-2-1-3: Further study is needed. Especially it is appreciated if we can hear the view on how much (or how accurate) the phase relationship between the two polarization signals needs to be maintained as the coherent receiver. vivo: further study is needed. This is a fundamental improvement of the test methodology.Qualcomm: Test modes are not appropriate for compliance testing, but we must rely on it when there is a TE shortcoming. RAN5 currently allows test modes for UEs during tests that require demodulation of uplink. This reliance on test modes in RAN5 can be eliminated by making the TE receiver OTA capable. Phase coherence requirements are easier for receivers because they can rely on slot-by-slot phase update from DMRS.R&S: Alt 2-2-1-3 (further study is needed).Huawei: prefer if TE can develop.Apple: Alt 2-2-1-1 (yes); we agree with companies’ comments that this is a fundamental improvement in test methodology; however, we understand this to be the only solution to remove the test mode configuration currently adopted by RAN5, which disables Tx diversity for all tests. That decision has essentially introduced a test mode for all Tx conformance tests, and we would like to begin the process of correcting this outcome. |

### 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** |
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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**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| Issue 2-1-1: Whether TPMI side conditions are feasible to introduce to the test setup | *Candidate options:*Alt 2-1-1-1: Yes Qualcomm, MediaTek, R&S (3)Alt 2-1-1-2: No Keysight, vivo, Samsung, Huawei, Apple (5)Alt 2-1-1-3: Further study is needed, including other options LGE, Sony (2)*Recommendations for 2nd round:*Proposal 2-1-1b: companies interested in enabling or further studying the TPMI solution are encouraged to provide a corresponding proposal to RAN Plenary to extend the scope of the SI to include this new objective. |
| Issue 2-1-2: How to define TPMI side conditions | *Recommendations for 2nd round:*Based on Proposal 2-1-1b, it is not recommended to further discuss this topic within the current scope of the SI. |
| Issue 2-1-3: Whether and, if feasible, how to modify the definition of the total EIRP calculation | *Recommendations for 2nd round:*Based on an overwhelming response, the recommendation is Alt 2-1-3-2 (No) |
| Issue 2-1-4: Whether polarization scan method is feasible | *Candidate options:*Alt 2-1-4-1: Yes Keysight, vivo, Apple (3)Alt 2-1-4-2: Yes, for Rel-15 only and as an optional technique [according to R4-2010129] LGE, Huawei (2)Alt 2-1-4-3: Adopt method 0 (current procedure in TR 38.810) as basis for EIRP testing, any potential enhanced procedure (e.g. method 1, 5, and 7) can be allowed for testing as optional for specific UE implementation based on UE declaration [according to R4-2011236] (0)Alt 2-1-4-4 No Anritsu, Samsung, Qualcomm, R&S, Sony (5)*Recommendations for 2nd round:*Five companies have expressed support for polarization scan, and five companies have expressed opposition. This issue remains open. |
| Issue 2-1-5: Whether a test mode to trigger TX diversity is sufficient and feasible | *Candidate options:*Alt 2-1-5-1: Yes vivo, Samsung, Huawei (3)Alt 2-1-5-2: No Qualcomm, MediaTek, Anritsu, Sony, Apple (5)*Recommendations for 2nd round:*Based on majority view, it is recommended not to consider test modes to trigger TX diversity (Alt 2-1-5-2). |
| Issue 2-1-6: Whether a power up command to trigger TX diversity is sufficient and feasible | *Candidate options:*Alt 2-1-6-1: Yes Sony (1)Alt 2-1-6-2: No Samsung, Qualcomm, MediaTek, Apple (4)(new) Alt 2-1-6-3: Further clarification is needed vivo, LGE, Huawei (3)*Recommendations for 2nd round:*Proposal 2-1-6b: Whether a power up command to trigger TX diversity is sufficient and feasible is FFS. |
| Issue 2-1-7: Whether 2-port CSI-RS is feasible to introduce to the test setup | *Candidate options:*Alt 2-1-7-1: Yes MediaTek (1)Alt 2-1-7-2: No Samsung (1)(new) Alt 2-1-7-3: Yes (qualified by Qualcomm comment) Qualcomm (1)(new) Alt 2-1-7-4: Further clarification is needed R&S, Sony (2)*Recommendations for 2nd round:*No decision seems possible on this issue. Interested companies are encouraged to bring further contributions on the topic to provide further clarification, but no agreement is possible this meeting. |
| Issue 2-1-8: 2-port CSI-RS shall be simultaneous or sequential | Based on Issue 2-1-7, no agreement is possible this meeting. |
| Issue 2-2-1: Whether FR2 test equipment topology shall be enhanced by adopting dual polarization coherent receivers | *Candidate options:*Alt 2-2-1-1: Yes Qualcomm, Huawei, Apple (3)Alt 2-2-1-2: No (0)Alt 2-2-1-3: Further study is needed Keysight, Anritsu, vivo, R&S (4)*Recommendations for 2nd round:*Given that no company has voiced opposition to either adopting the dual polarization coherent receiver approach or performing further study, it is reasonable to conclude that the group is open toward taking this approach as a starting point with a view toward developing further details in future meetings.Proposal 2-2-1b: The dual polarization coherent receiver topology is taken as a starting point, and companies are encouraged to contrbute in the next meeting with test setup descriptions, impact on test time, preliminary MU, and the method’s feasibility. |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on the polarization mismatch objective | Samsung |

### 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)

Issue 2-1-4: Whether polarization scan method is feasible

*Candidate options:*

Alt 2-1-4-1: Yes

 Keysight, vivo, Apple (3)

Alt 2-1-4-2: Yes, for Rel-15 only and as an optional technique [according to R4-2010129]

 LGE, Huawei (2)

Alt 2-1-4-3: Adopt method 0 (current procedure in TR 38.810) as basis for EIRP testing, any potential enhanced procedure (e.g. method 1, 5, and 7) can be allowed for testing as optional for specific UE implementation based on UE declaration [according to R4-2011236]

 (0)

Alt 2-1-4-4 No

 Anritsu, Samsung, Qualcomm, R&S, Sony (5)

*Recommendations for 2nd round:*

Five companies have expressed support for polarization scan, and five companies have expressed opposition. This issue remains open.

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| **Company** | **Comments** |
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Issue 2-1-6: Whether a power up command to trigger TX diversity is sufficient and feasible

Proposal 2-1-6b: Whether a power up command to trigger TX diversity is sufficient and feasible is FFS.

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| **Company** | **Comments** |
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Issue 2-1-7: Whether 2-port CSI-RS is feasible to introduce to the test setup

*Candidate options:*

Alt 2-1-7-1: Yes

 MediaTek (1)

Alt 2-1-7-2: No

 Samsung (1)

(new) Alt 2-1-7-3: Yes (qualified by Qualcomm comment)

 Qualcomm (1)

(new) Alt 2-1-7-4: Further clarification is needed

 R&S, Sony (2)

*Recommendations for 2nd round:*

No decision seems possible on this issue. Interested companies are encouraged to bring further contributions on the topic to provide further clarification, but no agreement is possible this meeting.

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| **Company** | **Comments** |
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Issue 2-2-1: Whether FR2 test equipment topology shall be enhanced by adopting dual polarization coherent receivers

Proposal 2-2-1b: The dual polarization coherent receiver topology is taken as a starting point, and companies are encouraged to contrbute in the next meeting with test setup descriptions, impact on test time, preliminary MU, and the method’s feasibility.

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| **Company** | **Comments** |
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WF on the polarization mismatch objective (Samsung)

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| **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”* |

# Topic #3: Inter-band CA within FR2

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2009962](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2009962.zip) | Apple Inc. | **Views on test methodology for inter-band CA within FR2**Proposal 1: Further study is needed to determine whether non-colocated test antennas for DL inter-band CA verification is feasible from the perspective of ∆PSD at the UE after spatial filtering. |
| [R4-2010802](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2010802.zip) | Rohde & Schwarz | **Discussion on open issues of inter-band CA testability**Observation 1: Providing DL signals from the same AoA inter-band CA in FR2 with 2 bands is feasible for the Rel-16 frequency bands, without exceeding the MU for single carrier/intra-band CA.Observation []: Imbalance can be larger for a single antenna test system, than estimated in [7].Proposal 1: RAN4 agrees that the testing of Rel-16 inter-band CA using a single antenna from 1AoA is feasible.Proposal 2: RAN4 discusses above questions to clarify the testing implications for inter-band CA with power imbalance. |

## 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 3-1: Need for offset feed antennas

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 3-1-1: Whether offset feed antennas need to be used for the FR2 DL inter-band CA test setup**

* Proposals
	+ Alt 3-1-1-1: Yes [see R4-1913931]
	+ Alt 3-1-1-2: FFS: Evaluation of impact on UE performance (e.g. PSD difference) is needed
	+ Alt 3-1-1-3: No (i.e. RAN4 agrees that using 1 AoA with single feed antenna is feasible) [see R4-2010802]

## Companies views’ collection for 1st round

### Open issues

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| **Issue** | **Company Comments** |
| Issue 3-1-1: Whether offset feed antennas need to be used for the FR2 DL inter-band CA test setup | Anritsu: Alt 3-1-1-1 Yes. But of course not forcing to use the offset antenna with every test system. We rather think that the design of the test system should be allowed to have a flexibility as far as the system keeps the measurement uncertainty within the maximum test system uncertainty (MTSU).Rationales to support Alt 3-1-1-1 are as follows.1. Considering the situation that we are studying 47GHz band or even higher frequency such as 52GHz or more, we should avoid a description which may limit the future system design and cause another testability issues. Especially with the situation that more and more wider aggregated channel bandwidth is required.
2. Unfortunately to say, RAN5 has not finished defining the measurement uncertainty for CA test cases (even with the single carrier cases). Thus we assume it is not mature to conclude that the system which is capable of transmitting 2 carriers from 1AoA can cover all the TRx test cases without giving any impacts on the existing single carrier test cases.
3. There should be some ways to calibrate out the possible gain difference due to the corresponding antenna offset from the test equipment, for example the beam peak search can be carried out by both main antenna and offset antenna if the beam management of the UE is independent. Or perhaps we can utilize the functionality of UE beam lock for Rx and check the gain difference by measuring EIS from both main antenna and offset antenna. Thus gain loss of the UE antenna should be mitigated to the level which we can ignore the MU compared to the other major factor.
4. FR2 test systems which were introduced in the market in an early stage such as year 2019 are not designed to cover test cases for CA for the sake of prioritizing tests for the single carrier. Thus there is a concern with the possibility of impacts to the existing single carrier tests when upgrading those systems to support 2CA input from 1AoA.

Qualcomm: We agree with Apple’s suggestion that the spatial filtering effect may need further investigation in context of non-co-located antennae, to cover all power classes. Another aspect to consider while making this determination is the introduction of the 47.2 to 48.2 GHz band.R&S: Alt 3-1-1-3 No. Based on our analysis it is not required with the currently defined requirements and bands. Also we don’t see any impact on already defined single carrier TCs and MUs by RAN5. Also currently all requirements (e.g. blocking) are defined under the assumption of same angle of arrival. When taking into account the new bands under discussion (n262), it would need to be taken into account during requirements definition if offset antennas are required.Huawei: both test solutions are allowed to further study. |

### 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**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| Issue 3-1-1: Whether offset feed antennas need to be used for the FR2 DL inter-band CA test setup | *Candidate options:*Alt 3-1-1-1: Yes [see R4-1913931] Anritsu (1)Alt 3-1-1-2: FFS: Evaluation of impact on UE performance (e.g. PSD difference) is needed Apple, Qualcomm (2)Alt 3-1-1-3: No (i.e. RAN4 agrees that using 1 AoA with single feed antenna is feasible) [see R4-2010802] R&S (1)(new) Alt 3-1-1-4: 1 AoA with single feed antenna and offset feed antenna methods are allowed for further study Huawei (1)*Recommendations for 2nd round:*One company provided valuable additional information to further justify the offset feed antenna method, and a majority of companies have supported further study of the method.Proposal 3-1-1a: Evaluation of impact on UE performance (e.g. PSD difference) is needed to determine the feasibility of the offset antenna method.Proposal 3-1-1b: Whether the offset feed antenna method is necessary to address band n262 testability is FFS. |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on the inter-band CA within FR2 objective | Anritsu |

### 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)

Issue 3-1-1: Whether offset feed antennas need to be used for the FR2 DL inter-band CA test setup

Proposal 3-1-1a: Evaluation of impact on UE performance (e.g. PSD difference) is needed to determine the feasibility of the offset antenna method.

Proposal 3-1-1b: Whether the offset feed antenna method is necessary to address band n262 testability is FFS.

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| **Company** | **Comments** |
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WF on the inter-band CA within FR2 objective (Anritsu)

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| **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”* |

# Topic #4: Others

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2009959 | Apple Inc. | **FR2 test method enhancement informal email discussion summary** |
| [R4-2009773](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2009773.zip) | Fraunhofer HHI, Fraunhofer IIS | **Beam sweeping and test time reduction in FR2**Observation []:Issue to be addressedâ€”reduction of measurement uncertainty.Observation []:Issue to be addressedâ€”reduction of measurement time.Observation []:Beam sweeping can be used to reduce the time needed for FR2 testing.Proposal []: As part of the enhanced test methods for FR2 study item, RAN4 should discuss beam sweeping techniques further. |
| [R4-2011236](http://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_96_e/Docs/R4-2011236.zip) | vivo, CAICT | **On enhanced test methods for FR2 RF**Observation 1: Developing specialized test systems is the only feasible way we can go at this stage, before some magical FR2 OTA systems appear. Otherwise, relaxation or remove of these high-DL-power and low-UL-power TCs shall be considered.Observation 2: End-to-end analysis of the system path loss is beneficial to check the maximum/minimum power of the system and compare directly with the required power of these TCs. Frequency up&down conversion can be a further optimization to reduce the length of mm-Wave cables in the enhanced system.Proposal 1: The study should initially focus on how to develop specialized test system to seek a reasonable solution for Objective 1.Proposal 2: Before adopting â€œWhite boxâ€ approach for enhanced FR2 RF test methodology, which detailed information from the vendor declaration is necessary should be discussed and decided.Proposal 3: System dynamic range study is strongly encouraged to compare the capability of the system with the required power of these unresolved TCs.Proposal 4: Adopt method 0 (current procedure in TR 38.810) as basis for EIRP testing, any potential enhanced procedure (e.g. method 1, 5, and 7) can be allowed for testing as optional for specific UE implementation based on UE declaration. |

*The Moderator’s recommendations for these documents are the following:*

*R4-2009959: recommend noting, as it is for information only*

*R4-2009773: recommend postponing until the remaining objectives in the SI are added to the agenda*

*R4-2011236: recommend noting; Proposals 1, 2, 3 are handled in Topic #1, and Proposal 4 is handled in Topic #2*