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TECHNICAL REPORT

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# Foreword

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**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The objectives for FR2-1 OTA testing for UEs with simultaneous transmission with multi-panel (STxMP) are as follows.

- Study and define RF testing methodology for FR2 non-handheld UE that can transmit simultaneously with multi-panel
- Define the measurement setup and test procedure for configured transmitted power requirements for simultaneous transmission to multiple directions
- Selecting proper AoA pairs for verification perspective
- Target PC1/PC5 devices as the 1st priority.
- Develop the related preliminary uncertainty assessments for the test methodology
- FR2 test methods for multi-Rx chain DL reception defined in TR 38.871 should be used as the baseline.
- The tests shall take the test system reuse, test system complexity and test time into account to keep the whole test costs within a reasonable level.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
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[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.101-2: "User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[3] 3GPP TR 38.810: "Study on test methods".

[4] 3GPP TR 38.884: " Study on enhanced test methods for FR2 NR UEs".

[5] 3GPP TR 38.871: "Study on NR frequency range 2 (FR2) Over-the-Air (OTA) testing enhancements".

[6] 3GPP TS 38.508-1, "User Equipment (UE) conformance specification; Part 1: Common test environment".

[7] 3GPP TR 38.903, "Derivation of test tolerances and measurement uncertainty for User Equipment (UE) conformance test cases".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**FWA UE:** A UE intended to be used in fixed wireless access scenario.

**Handheld UE:** A UE intended to be used in handheld scenario.

**Vehicular UE:** A UE embedded in a vehicle.

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

θ Zenith angle in the spherical co-ordinate system, as well as measurement antenna polarization along the direction of motion of the zenith axis rotation.

ϕ Azimuth angle in the spherical co-ordinate system, as well as measurement antenna polarization along the direction of motion of the azimuth axis rotation.

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

| | |
|---|---|
| A-MPR | Additional Maximum Power Reduction |
| AoA | Angle of Arrival |
| DFF | Direct Far Field |
| DUT | Device Under Test |
| EIRP | Effective (or equivalent) isotropic radiated power |
| EIRPmax | The applicable maximum EIRP as specified in sub-clause 6.2 of TS 36.101-2 [2] |
| FR2 | Frequency Range IFF Indirect Far Field |
| FWA | Fixed Wireless Access |
| IFF | Indirect Far Field |
| MPR | Allowed maximum power reduction |
| MU | Measurement Uncertainty |
| NR | New Radio |
| OTA | Over The Air |
| STxMP | Simultaneous Transmission with Multi-Panel |
| TCI | Transmission Configuration Indicator |
| TRP | Total Radiated Power |
| TRPmax | The maximum TRP for the UE power class as specified in sub-clause 6.2 of TS 36.101-2 [2] |
| TT | Test Tolerance |
| UE | User Equipment |

# 4 General

## 4.1 Objective

In Rel-18 WI on MIMO Evolution for Downlink and Uplink (Acronym: NR_MIMO_evo_DL_UL), one of the objectives is to study, and if needed, extend the specification to facilitate simultaneous transmission with multi-panel (STxMP), targeting CPE/FWA/vehicle/industrial devices. With the UE RF requirements for PC1/PC2/PC5/PC6 were specified for STxMP scenarios in RAN4, the test methodology for FR2 non-handheld UE supporting simultaneous transmission with multi-panel need to be enhanced. This document is to define the enhanced test methodology, measurement setup and test procedure for the verifications of configured transmitted power requirements for simultaneous transmission to multiple directions.

## 4.2 Devices Type

The development of test methods shall focus on PC1/PC5 devices as the 1st priority. Other non-handheld UE types such as vehicle and industrial devices are precluded due to lack of core requirements.

# 5 UE RF testing methodology for STxMP

## 5.1 General

The test methodology defined in this document only applies for STxMP testing with two-layer transmission (i.e., one layer per TCI). The methodology for single layer transmission with STxMP needs to be further studied when the corresponding core requirements are completed.

## 5.2 Measurement setup

Through the analysis of system complexity, feasibility of guaranteeing the same relative angular orientations between specific UE test directions and probes, etc, it was confirmed that the baseline multi-Rx system is suitable for STxMP testing. Therefore, the measurement setup with full degrees of freedom for AoA1 with fixed angular Offset(s) between AoA1 and AoA2 and with all probes located on the xz plane specified in Clause 5.2.2 of [5] can be reused for STxMP testing. An example baseline system for multi-RX and/or STxMP with 4 discrete probes in the xz plane is shown in Figure 5.2-1.

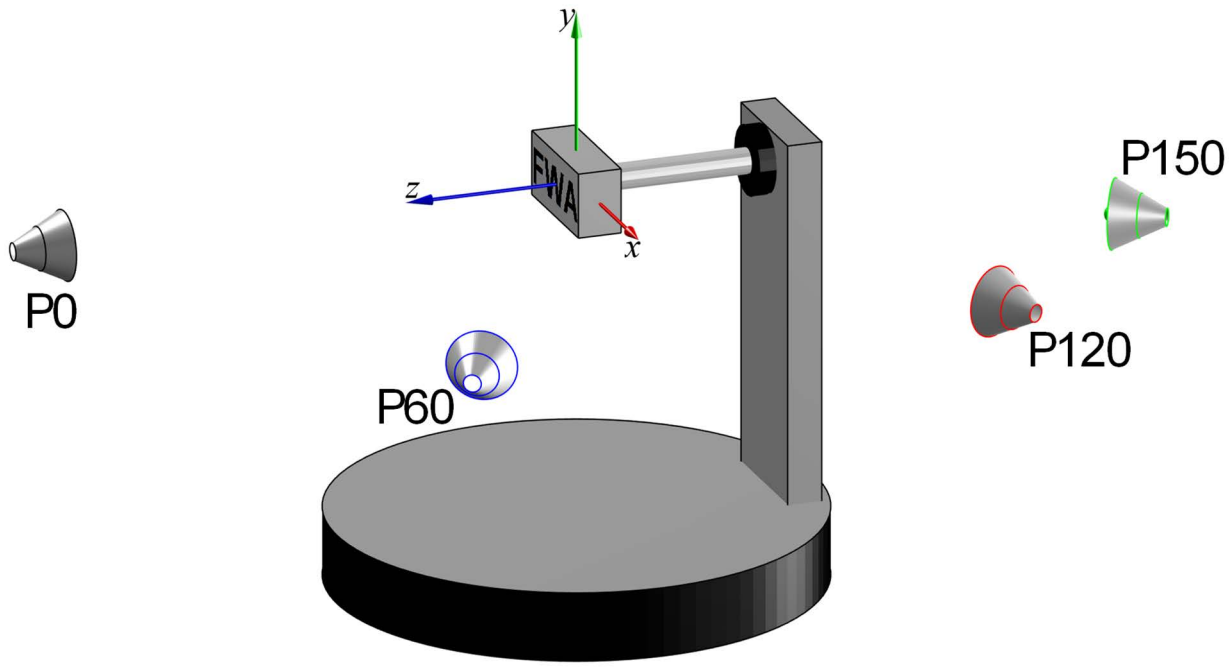


**Figure 5.2-1: Example multi-RX/STxMP system implementation**

The example multi-AoA measurement setups are similar to baseline setups for 2 AoA RRM testing [6], see Clause B.2, as illustrated in Figure 5.2-2 with the added requirement that the measurement probes/reflectors are placed in the xz plane. The number of probes is up to system implementation. .

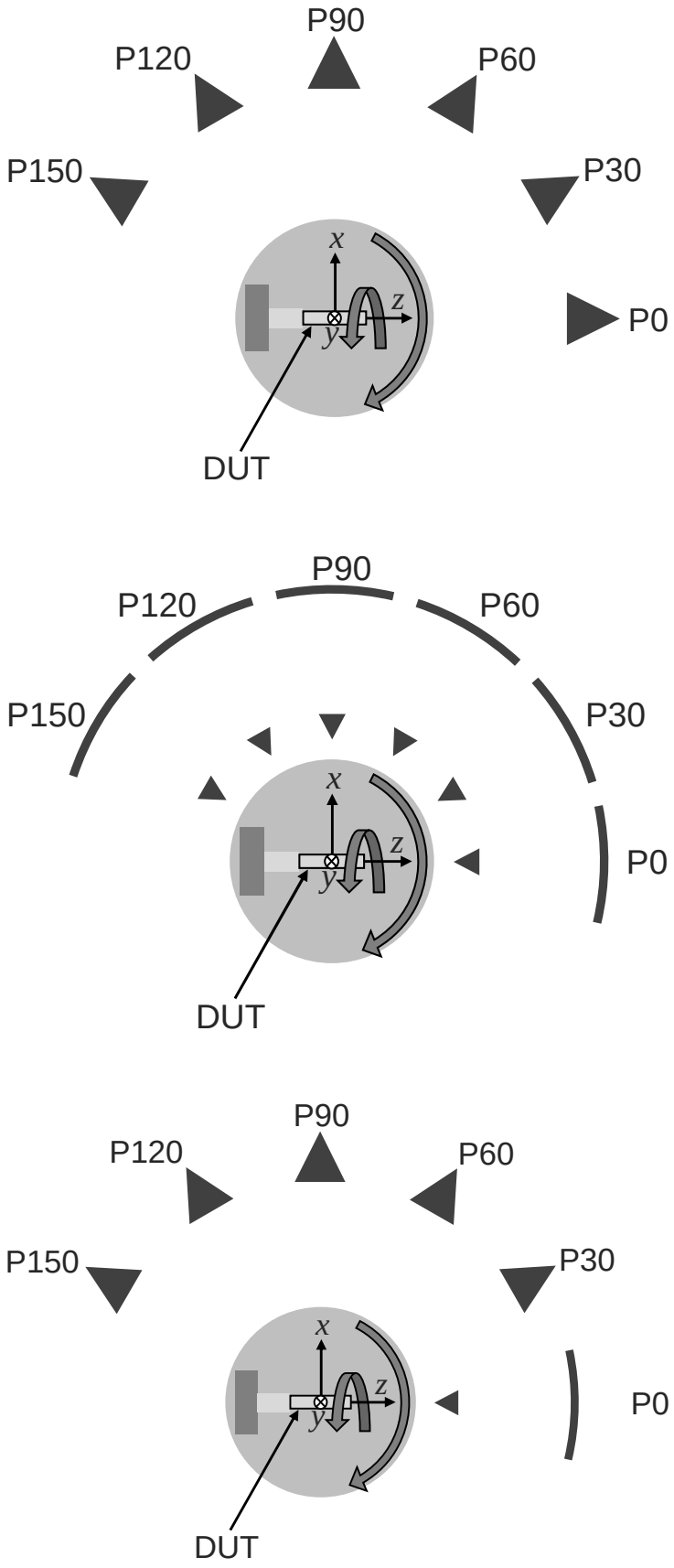


**Figure 5.2-2: Example RRM baseline system with two simultaneously active AoA using top: DFF setup, centre: Enhanced IFF setup, bottom: IFF+DFF setup.**

# 5.3 Test System Aspects

## 5.3.1 Absolute Probe Locations

Given the rotational symmetry, the systems shown in Figure 5.2-1 and Figure 5.2-2 with different absolute probe locations shall still be able to guarantee the same relative angular orientations between specific UE test directions and probes provided the baseline system with probes in the *xz* plane and angular sweeps of $0 \leq \theta < 360°$ and $0 \leq \phi < 180°$ are supported. For more details, refer to Clause 5.3.1 of [5].

## 5.3.2 AoA1-AoA2 DL Orientation Vectors

It was agreed that the directionality of the AoA1-AoA2 DL orientation vectors matters. Given RAN4 has confirmed that the baseline multi-RX/STxMP system is suitable to guarantee the same relative angular separations between specific UE test orientations and probes, similar as multi-Rx test system specified in [5], the impact of directionality of the AoA1-AoA2 orientation vectors shall also be accommodated in the measurement to ensure no testing bias is introduced.

## 5.3.3 Calibration measurement procedure

The calibration measurement per DFF probe and IFF probe specified in Clause 5.4 of [5] can be reused for STxMP testing.

# 5.4 Test procedure

## 5.4.1 Min peak EIRP

The min peak EIRP requirement for STxMP is defined at the beam peak direction for each of the indicated joint/UL TCI states. However, the beam peak search procedure is not suitable for STxMP due to the following reasons:

- Since only several fixed AoA separations can be chosen in the test system, it is hard to guarantee the tested AoA is exactly aligned with beam peak direction from each panel.
- The mapping between probe and UE panel may change during the beam peak search, and the test results of each probe contain the radiated power from both panels and cannot differentiate two beam peaks clearly.

Two possible tested method to verify the requirement without beam peak search are proposed:

- Option 1: Consider similar as multi-Rx UE declaration approach for one AoA pair selecting from the set of {30deg, 60deg, 90deg, 120deg, 150deg} and one proper UE orientation listed in TS 38.101-2 [2] for EIRP per TCI measurement.
- Option 2: For the selection of AoA pair, one of AoA is at the beam peak direction of single CC operation without STxMP enable (from Beam Peak Search for MOP in 6.2 of TS 38.101-2 [2]), another AoA is decided by UE declared orientation (listed in TS 38.101-2 [2]) and AoA pair from set of {30deg, 60deg, 90deg, 120deg, 150deg}.

The main difference is whether let UE totally decide the AoA pair to be tested. The following simulation results show the EIRP at ideal beam peak of each panel and the maximum EIRP under declared AoA offset and UE orientation. The 1x4 panel is used as an example and two panels are located at opposite side.

**Table 5.4.1-1 EIRP at ideal beam peak and maximum EIRP based on UE declaration for Orientation#1**

| Orientation#1 AoA offset | panel #1 peak angle [theta, phi] | panel #1 peak EIRP /dBm | panel #2 peak angle [theta, phi] | panel #2 peak EIRP /dBm | AoA pair when AoA1 EIRP is maximum [$AoA1_{\varphi}$, $AoA1_{\theta}$] [$AoA2_{\varphi}$, $AoA2_{\theta}$] | AoA pair EIRP [AoA1,AoA2]/ dBm | AoA pair when AoA2 EIRP is maximum [$AoA1_{\varphi}$, $AoA1_{\theta}$] [$AoA2_{\varphi}$, $AoA2_{\theta}$] | AoA pair EIRP [AoA1,AoA2]/ dBm |
|---|---|---|---|---|---|---|---|---|
| 30° | [165,90] | 26.49 | [10,90] | 26.4 | [170,90] [170,120] | [26.44, 19.75] | [165,60] [165,90] | [19.29,26.49] |
| 60° | | | | | [165,90] [165,150] | [26.49,17.82] | [165,30] [165,90] | [15.34,26.49] |
| 90° | | | | | [165,90] [165,180] | [26.49,14.09] | [165,0] [165,90] | [16.48,26.49] |
| 120° | | | | | [165,90] [345,150] | [26.48,19.16] | [345,30] [165,90] | [17.84,26.49] |
| 150° | | | | | [165,90] [345,120] | [26.49,23.64] | [345,60] [165,90] | [23.00,23.49] |

**Table 5.4.1-2 EIRP at ideal beam peak and maximum EIRP based on UE declaration for Orientation #2**

| Orientation#2 AoA offset | panel #1 peak angle [theta, phi] | panel #1 peak EIRP /dBm | panel#2 peak angle [theta, phi] | panel #2 peak EIRP /dBm | AoA pair when AoA1 EIRP is maximum [$AoA1_{\varphi}$, $AoA1_{\theta}$] [$AoA2_{\varphi}$, $AoA2_{\theta}$] | AoA pair EIRP [AoA1,AoA2]/ dBm | AoA pair when AoA2 EIRP is maximum [$AoA1_{\varphi}$, $AoA1_{\theta}$] [$AoA2_{\varphi}$, $AoA2_{\theta}$] | AoA pair EIRP [AoA1,AoA2]/ dBm |
|---|---|---|---|---|---|---|---|---|
| 30° | [90,105] | 26.49 | [270,100] | 26.4 | [90,100] [90,130] | [26.44, 18.87] | [270,130] [270,100] | [18.87,26.40] |
| 60° | | | | | [90,105] [90,165] | [26.49,19.39] | [90,45] [90,105] | [19.43,26.49] |
| 90° | | | | | [90,105] [270,165] | [26.49,20.49] | [90,15] [90,105] | [21.37,26.49] |
| 120° | | | | | [90,105] [270,135] | [26.49,24.26] | [270,15] [90,105] | [23.00,26.49] |
| 150° | | | | | [90,105] [270,105] | [26.49,26.31] | [270,45] [90,105] | [23.79,23.49] |

The results show that based on UE declaration, one of AoA is always align with the ideal beam peak direction of panels when maximum EIRP is achieved, and under proper UE orientation and AoA offset, a AoA pair that close to the peak for each antenna module can be found, i.e., 150°AoA offset for Orientation#2 in above table. Therefore, the beam peak direction of single CC operation can be one of the candidates for STxMP verification.

After RAN4 discussion, the conclusion on AoA pair (AoA1 and AoA2) selection is as following which is a combination of Option 1 and Option 2:

- If UE declares the AoA1, then

  a) The declaration of AoA1 direction can be any direction but need to be aligned with the measurement grid of beam peak search of single CC without STxMP.

  b) AoA2 direction is to use AoA1 + or - UE declared offset from set of {30deg, 60deg, 90deg, 120deg, 150deg} in xz plane of test system

  c) The selection of 'AoA1+ UE declared offset' or 'AoA1 - UE declared offset' as AoA2 needs to be declared by UE

  d) If AoA1 and AoA2 directions pass EIRP $P_{UMAX,f,c,k}$ requirements, the DUT pass the test.

- If UE doesn't declare AoA1, then

a) the default AoA1, i.e., the beam peak direction of single CC operation without STxMP is applied

b) AoA2 direction is to use AoA1 + and - UE declared offset from set of {30deg, 60deg, 90deg, 120deg, 150deg} in xz plane of test system

c) AoA2 direction is AoA1 + the declared offset

d) AoA2 direction is AoA1 - the declared offset

e) If AoA1 and any of the two AoA2 directions pass EIRP $P_{UMAX,f,c,k}$ requirements, the DUT pass the test.

Note that the above AoA pair (AoA1 and AoA2) selection is based on the UE declared orientation.

The EIRP shall be measured per TCI with the configuration of rank 2 PUSCH transmission under SDM scheme, i.e., UE transmit signals with different layers for AoA1 direction and AoA2 direction respectively.

Testing polarization selection also needs to be investigated for STxMP. In the legacy single AoA testing there are four EIRP component testing (2 link pol x 2 measurement pol). The 2 measurement polarizations correspond to θ and ϕ EIRP component which cannot be reduced. The 2 link polarizations are measured in order to get the max total EIRP between the two link pol. When EIRP comes to 2AoA case, the whole EIRP measurements would be 4 link pol combinations x 4 EIRP components = 16 EIRP testing. It is agreed to limit the polarization combinations to simplify the test with crossed link polarization (‘θϕ’ and ‘ϕθ’) which also benefits lower interference between probes.

### 5.4.2 MPR/A-MPR

To avoid additional unwanted emission, 3dB relaxation is applied to the MPR/A-MPR of STxMP requirement and legacy MPR/A-MPR is reused for each of the indicated joint/UL TCI states. The UE can satisfy the requirement only if the legacy MPR/A-MPR requirement can be met when only one panel is activated, so it is concluded that the MPR/A-MPR is unnecessary to be verified.

### 5.4.3 EIRPmax

Unlike min peak EIRP, the radiated power from both panels needs to be aggregated for EIRPmax verification, and the aggregated power at any direction should not exceed the defined requirement. The following simulation results show the maximum aggregated power and related AoA pair, and the simulation setup is same as min peak EIRP.

**Table 5.4.3-1 Maximum aggregated power and related AoA pair**

| | **AoA offset** | **AoA pair of aggregated EIRPmax across all tested beam pair [$AoA1_{\varphi}$, $AoA1_{\theta}$] [$AoA2_{\varphi}$, $AoA2_{\theta}$]** | **EIRPmax** | **Beam peak direction when only one panel is activated [φ, θ]** |
|---|---|---|---|---|
| Panels in same side | 30° | [270,105] [270,75] | 29.22 | [270,105] |
| | 60° | [270,105] [270,45] | 29.22 | |
| | 90° | [270,105] [270,15] | 29.22 | |
| | 120° | [270,105] [90,15] | 29.22 | |
| | 150° | [270,105] [90,45] | 29.22 | |
| Panels in opposite side | 30° | [90,105] [90,135] | 26.97 | [90,105] |
| | 60° | [90,95] [90,155] | 26.94 | |
| | 90° | [90,95] [270,175] | 26.94 | |
| | 120° | [90,95] [270,145] | 26.94 | |
| | 150° | [90,95] [270,115] | 26.94 | |

For the AoA pair to achieve maximum aggregated power, one of AoA is align with the legacy beam peak direction, but the AoA separation is not always same as the UE declared in min peak EIRP which depends on UE implementation. Therefore, the following two sets of AoA separation and UE orientation needs to be tested for EIRPmax compliance

- The AoA separation and UE orientation declared by UE for EIRP $P_{UMAX,f,c,k}$ testing.

- One of AoA is at the beam peak direction of single CC operation without STxMP enabled, the other AoA is at the direction decided by UE declared orientation (listed in TS 38.101-2 [2]) and 30deg AoA separation.

In theory, as long as the measured the EIRPmax for single carrier operation is 3dB lower than the EIRPmax requirement, the measured EIRPmax under STxMP 2AoA transmission should also lower than the EIRPmax requirement. After RAN4 discussion, 0.5dB margin is applied to guarantee the regulation requirement can be satisfied for sure, so the following test skipping rule is agreed:

- If the measured the EIRPmax for single carrier operation is 3.5dB lower than the EIRPmax requirement, the EIRPmax test for STxMP can be skipped.

### 5.4.4 TRPmax

For TRPmax, same approach as EIRPmax is used to decide the AoA pair and UE orientation.

In theory, as long as the measured the TRPmax for single carrier operation is 3dB lower than the TRPmax requirement, the measured TRPmax under STxMP 2AoA transmission should also lower than the TRPmax requirement. After RAN4 discussion, 0.5dB margin is applied to guarantee the regulation requirement can be satisfied for sure, so the following test skipping rule is agreed:

- If the measured the TRPmax for single carrier operation is 3.5dB lower than the TRPmax requirement, the EIRPmax test for STxMP can be skipped.

# 6 Summary

This technical report outlines the UE RF testing methodology used to verify new requirements for FR2 PC1/PC5 UE with STxMP. Based on an analysis of system complexity and the feasibility of maintaining consistent relative angular orientations between specific UE test directions and probes, the multi-Rx system defined in [5] with fixed angular offsets between AoA1 and AoA2 and positions all probes on the xz plane, is suitable for STxMP testing.

With consensus on the measurement setup, the procedures for minimum peak EIRP, maximum EIRP, and maximum TRP are defined. It is important to note that the procedures described in this document apply exclusively to STxMP testing with two-layer transmission (i.e., one layer per TCI). The methodology for single-layer transmission with STxMP will require further study once the relevant core requirements are finalized.

Additionally, a preliminary measurement uncertainty budget is provided. Different from legacy uncertainty assessments budget, RAN4 decided to use an additional Test Tolerance to accommodate the difference from the core requirement derivation and test system restrictions due to finite resolution. With the evaluations, RAN4 concluded that AoA1 and AoA2 will have the same additional test tolerance of 0.9dB.

# Annex A: Measurement uncertainty budget for STxMP UE RF testing methodology

The uncertainty tables shall be presented with two stages:

- Stage 1: the calibration of the absolute level of the DUT measurement results is performed by means of using a calibration antenna whose absolute gain is known at the frequencies of measurement
- Stage 2: the actual measurement with the DUT as either the transmitter or receiver is performed.

MU for STxMP testing which is leveraged from legacy EIRP/TRP MU budget for PC1 and PC5 specified in Table B.3.2-6 of [7].

Compared to legacy uncertainty assessments for UE RF testing defined in [7], the value for the uncertainty source of systematic error related to beam peak search can be set as 0. The error due to finite testing directions can be handled in test tolerance. How to impact TT will be finalized in RAN5.

The preliminary MU budget for UE RF testing methodology is defined in Table A.1-1.

**Table A.1-1: Uncertainty assessment for Minimum EIRP, EIRPmax and TRP measurement (f=23.45GHz, 32.125GHz, 40.8GHz, Quiet Zone size ≤ 30 cm) for PC1 and PC5 UEs and normal temperature condition**

| UID | Uncertainty source | Uncertainty value | Distribution of the probability | Divisor | Standard uncertainty (σ) [dB] |
|---|---|---|---|---|---|
| **Stage 2: DUT measurement** | | | | | |
| 1 | Positioning misalignment | 0.02 | Normal | 2.00 | [0.01] |
| 2 | Measure distance uncertainty | 0.00 | Rectangular | 1.73 | [0.00] |
| 3 | Quality of Quiet Zone (NOTE 1) | 0.6 | Actual | 1.00 | [0.6] |
| 4 | Mismatch | 1.30 | Actual | 1.00 | [1.30] |
| 5 | Standing wave between the DUT and measurement antenna | 0.00 | U-shaped | 1.41 | [0.00] |
| 6 | Uncertainty of the RF power measurement equipment (NOTE 3) | 2.16 | Normal | 2.00 | [1.08] |
| 7 | Phase curvature | 0.00 | U-shaped | 1.41 | [0.00] |
| 8 | Amplifier uncertainties | 2.10 | Normal | 2.00 | [1.05] |
| 9 | Random uncertainty | 0.50 | Normal | 2.00 | [0.25] |
| 10 | Influence of the XPD | 0.01 | U-shaped | 1.41 | [0.00] |
| 11 | Insertion Loss Variation | 0.00 | Rectangular | 1.73 | [0.00] |
| 12 | RF leakage (from measurement antenna to the receiver/transmitter) | 0.00 | Actual | 1.00 | [0.00] |
| 13 | Influence of TRP measurement grid (NOTE 4) | 0.25 | Actual | 1 | [0.25] |
| 14 | Influence of beam peak search grid (NOTE 5) | 0.00 | Actual | 1 | [0.00] |
| 15 | Multiple measurement antenna uncertainty (NOTE 9) | 0.15 | Actual | 1 | [0.15] |
| 16 | DUT repositioning | 0.00 (NOTE 4)<br>0.35 (NOTE 5) | Rectangular | 1.73 | [0.00] (NOTE 4)<br>[0.20] (NOTE 5) |
| **Stage 1: Calibration measurement** | | | | | |
| 17 | Mismatch | 0.00 | U-shaped | 1.41 | [0.00] |
| 18 | Amplifier Uncertainties | 0.00 | Normal | 2.00 | [0.00] |
| 19 | Misalignment of positioning System | 0.00 | Normal | 2.00 | [0.00] |
| 20 | Uncertainty of the Network Analyzer | 1.50 | Normal | 2.00 | [0.75] |
| 21 | Uncertainty of the absolute gain of the calibration antenna | 0.60 | Normal | 2.00 | [0.30] |
| 22 | Positioning and pointing misalignment between the reference antenna and the measurement antenna | 0.01 | Rectangular | 1.73 | [0.00] |
| 23 | Phase centre offset of calibration antenna | 0.00 | Rectangular | 1.73 | [0.00] |
| 24 | Quality of quiet zone for calibration process (NOTE 1) | 0.4 | Actual | 1.00 | [0.4] |
| 25 | Standing wave between reference calibration antenna and measurement antenna | 0.00 | U-shaped | 1.41 | [0.00] |
| 26 | Influence of the calibration antenna feed cable | 0.14 | Normal | 2.00 | [0.07] |
| 27 | Insertion Loss Variation | 0.00 | Rectangular | 1.73 | [0.00] |
| | **Systematic uncertainties (NOTE 6)** | | | | **Value** |
| 28 | Systematic error due to TRP calculation/quadrature (NOTE 4) | | | | [0.00] |
| 29 | Influence of noise (23.45GHz <= f <= 32.125GHz) | | | | [0.13] |
| 29 | Influence of noise (32.125GHz < f <= 40.8GHz) | | | | [0.27] (NOTE 4)<br>[0.20] (NOTE 5) |
| 30 | Systematic error related to beam peak search (NOTE 5) | | | | [0.70] |
| Total measurement uncertainty | | | | | Value |
| EIRP Expanded uncertainty (23.45GHz <= f <= 32.125GHz) (1.96σ - confidence interval of 95 %) [dB] | | | | | [5.33] |
| EIRP Expanded uncertainty (32.125GHz < f <= 40.8GHz) (1.96σ - confidence interval of 95 %) [dB] | | | | | [5.40] |
| TRP Expanded uncertainty (23.45GHz <= f <= 32.125GHz) (1.96σ - confidence interval of 95 %) [dB] | | | | | [4.64] |

| | |
|---|---|
| TRP Expanded uncertainty (32.125GHz < f <= 40.8GHz) (1.96σ - confidence interval of 95 %) [dB] | [4.78] |
| NOTE 1: The quality of quiet zone is the same for EIRP and TRP. Value based on procedure defined in clause D.2 of TR 38.810 for Quiet Zone size less or equal to 30 cm.<br>NOTE 2: The analysis was done only for the case of operating at max output power, in-band, non-CA and is valid for SISO and MIMO.<br>NOTE 3: The assessment assumes maximum DUT output power.<br>NOTE 4: This contributor shall only be considered for TRP measurements.<br>NOTE 5: This contributor shall only be considered for EIRP measurements.<br>NOTE 6: In order to obtain the total measurement uncertainty, systematic uncertainties have to be added to the expanded root sum square of the standard deviations of the Stage 1 and Stage 2 contributors.<br>NOTE 7: Void.<br>NOTE 8: Void<br>NOTE 9: Applies to the system which has a structure of mechanical feed antenna positioning. declaration. | |

The impact due to finite testing directions including limited choices for AoA1&AoA2 test directions can be handled in an additional Test Tolerance, $TT_{FiniteRes}$. FFS on the value of $TT_{FiniteRes}$. Therefore, the total Test Tolerance determined as a function of MU could be given by $TT_{Total} = x*MU_{Total} + TT_{FiniteRes}$ where x is determined in RAN5. Considering only finite separations between AoAs can be declared, the deviation from beam peak could happen and several typical cases (panels in same face, panels in adjacent faces, and panels in opposite faces) are shown in Figure A.1-1.

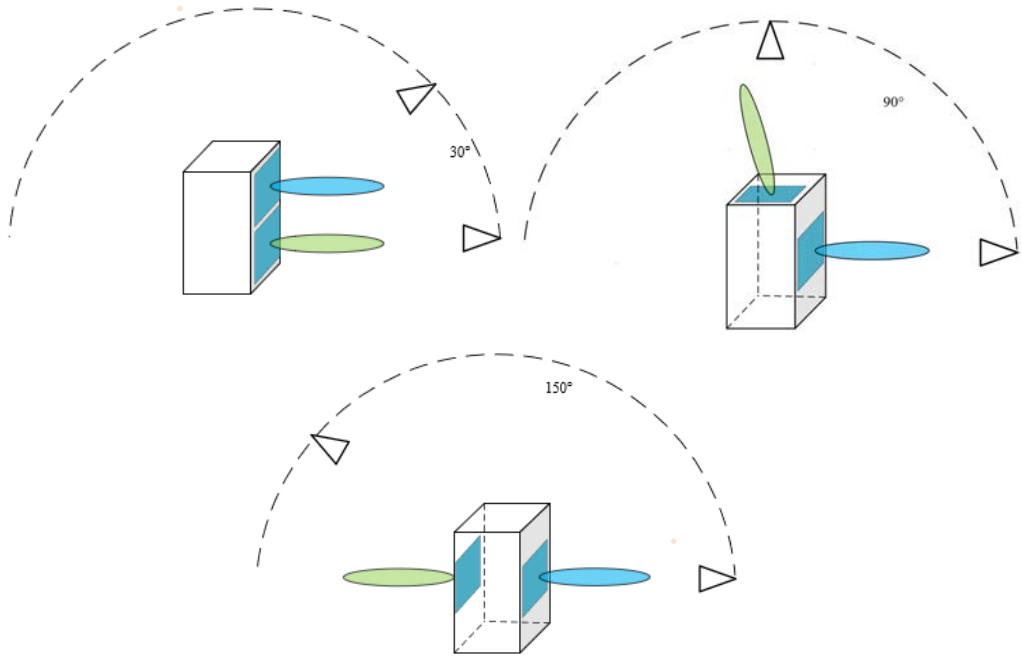


**Figure A.1-1 Possible cases of deviation of beam peak**

The worst case of deviation can be 30°, and Figure A.1-2 show the simulation results of antenna gain degradation. The deviation is uniformly distributed within [-30°,30°] and the simulation assumptions are listed in Table A.1-1.

**Table A.1-1: PC5 FWA device and antenna assumptions**

| | |
|---|---|
| Number of antenna arrays | 2 |
| Number of elements in array | 12x12, 6x6 |

| | |
|---|---|
| Beam steering range and granularity in xz plane | 4º beam steering granularity (from 0º to 180º) |
| Beam steering range and granularity in xy plane | 4º beam steering granularity (from 0º to 180º) |

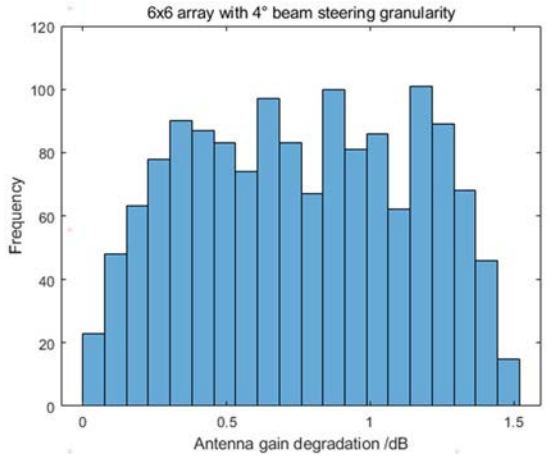


**Figure A.1-2 Degradation when the AoA is deviated from beam peak within [-30°,30°]**

It is observed that up to 1.6 dB degradation could be caused by the beam peak mismatch for 6x6 array. By changing the array from 6x6 to 12x12, up to 1.8dB degradation is obtained from simulation. Such results can also be reproduced for the case where two panels are located in opposite faces. For the case where two panels are located in adjacent faces, simulation results in R4-2506974 shows up to 1.5dB degradation.

Above simulation results show 1.5~1.8dB degradation for those typical panels location cases, and RAN4 agrees to take the worst case i.e. 1.8dB degradation for test tolerance derivation, so for PC1/PC5, $TT_{FiniteRes}$ = 0.9 dB is applied equally for AoA1 and AoA2.

Note: During simulation process, it is also observed that the test tolerance is sensitive to both beam array size and beam steering granularity. For difference device types other than PC1/PC5 which may have different array size and beam steering granularity, the 0.9dB test tolerance can not be reused directly and further evaluation is needed.

# Annex B: Change history

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2024-08 | R4#112 | R4-2413533 | | | | Initial skeleton | 0.0.1 |
| 2024-11 | R4#113 | R4-2418164 | | | | TR 38.771 for study on NR FR2 OTA testing phase 3<br>- R4-2419809, TP to TR 38.771 on the test procedure of sTxMP, vivo | 0.1.0 |
| 2025-02 | R4#114 | R4-2501728 | | | | TR 38.771 for study on NR FR2 OTA testing phase 3<br>- R4-2500508, TP to TR 38.771 on STxMP test procedure, Samsung<br>- R4-2501729, TP to TR 38.771 on general part, Qualcomm<br>- R4-2501730, TP to TR 38.771 on test methodology for STxMP, Qualcomm | 0.2.0 |
| 2025-04 | R4#114bis | R4-2504061 | | | | TR 38.771 for study on NR FR2 OTA testing phase 3<br>- R4-2504726, TP to TR 38.771 on MU, Qualcomm, vivo<br>- R4-2504567, TP for 38.771 on system related aspects, Keysight | 0.3.0 |
| 2025-08 | R4#116 | R4-2510238 | | | | TR 38.771 for study on NR FR2 OTA testing phase 3<br>- R4-2510237, TP to TR 38.771 for editorial changes, Qualcomm Incorporated<br>- R4-2512595, TP to TR 38.771 on FR2 sTxMP test tolerance, vivo, Qualcomm, Samsung, Keysight<br>- R4-2512594, TP to TR 38.771 for TR summary, Qualcomm Incorporated, vivo, Samsung, Keysight | 0.4.0 |
| 2025-09 | RAN#109 | RP-252376 | | | | For approval | 1.0.0 |

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2025-09 | RAN#109 | | | | | Approved by plenary – Rel-19 spec under change control | 19.0.0 |

# History

| Document history | | |
|---|---|---|
| V19.0.0 | October 2025 | Publication |
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