**3GPP TSG RAN WG4 Meeting #94bis-e R4-2005502**

**Electronic Meeting, 20 – 30 April, 2020**

**Source:** Rohde & Schwarz

**Title:** Ambiguity on two orthogonal polarizations measurements

**Agenda Item:** 6.19.2

**Document for:** Approval

# Introduction

As part of the work to clean-up and consolidate the required information for the purposes of the radiated testing of the BS into TR 37.941, some of the test procedures have been simplified and used over different test methodologies but, in certain cases, the selected formulation might drive to interpretation issues.

This contribution present one case and the corresponding proposal to solve it.

This is a revision of R4-2004392 to present necessary changes for all test cases where this change shall be implemented:

* Clause 9.2 - EIRP accuracy, Normal test conditions
* Clause 9.4 - OTA E-UTRA DL RS power
* Clause 9.5 - OTA output power dynamics

# Discussion

In current draft version of TR 37.941 [1], the expression used to require measurement on two orthogonal polarizations has been generalized as follows (example from clause 9.2 EIRP accuracy):

##### 9.2.2.2.2 Stage 2: BS measurement

The testing procedure consists of the following steps:

1) Uninstall the reference antenna and install the BS with the manufacturer declared coordinate system reference point in the same place as the phase centre of the reference antenna. The manufacturer declared coordinate system orientation of the BS is set to be aligned with the testing system.

2) Set the BS to generate the tested beam with the *beam peak direction* intended to be the same as the testing direction.

3) Rotate the BS to make the testing direction aligned with the direction of the receiving antenna.

4) Set the BS to transmit the test signal at the maximum power according to applicable test model.

5) Measure the mean power for each carrier arriving at the measurement equipment connector, denoted by PR\_EIRP, D, which is defined as measured mean power for each carrier at the measurement equipment connector at the reference point D in figure 7.2.1-1.

6) Calculate the EIRP with the following formula:

EIRP = PR\_EIRP, D + LEIRP\_cal, A→D

7) Calculate total EIRP = EIRPp1 + EIRPp2 where the declared beam is the measured signal at port 1 (p1) and port 2 (p2).

8) Repeat the above steps 2 - 7 per conformance test *beam direction pair*.

The wording highlighted in yellow may drive to misunderstanding where a test system with a dual polarized measurement antenna is required for testing, while a sequential measurement with a single polarized measurement antenna can also be used. The actual requirement from TS 38.141-2 [2] just mention the need for measurement on two orthogonal polarizations (example from clause 6.2 Radiated transmit power):

6.2.4.2 Procedure

For normal test environment conditions in OTA domain, the test procedure is as follows:

1) Place the BS at the positioner.

2) Align the manufacturer declared coordinate system orientation (D.2) of the BS with the test system.

3) Orient the positioner (and BS) in order that the direction to be tested aligns with the test antenna.

4) Configure the *beam peak direction* of the BS according to the declared *beam direction pair*.

5) Set the BS to transmit according to the applicable test configuration in subclause 4.8 using the corresponding test model(s) in subclause 4.9.2.

For a BS declared to be capable of multi-carrier and/or CA operation use the applicable test signal configuration and corresponding power setting specified in subclauses 4.7.2 and 4.8 using the corresponding test model(s) in subclause 4.9.2 on all carriers configured.

6) Measure EIRP for any two orthogonal polarizations (denoted p1 and p2) and calculate total radiated transmit power for particular *beam direction pair* as EIRP = EIRPp1 + EIRPp2.

7) Test steps 3 to 6 are repeated for all declared beams (D.3) and their reference *beam direction pairs* and *maximum steering directions* (D.8 and D.10).

For multi-band capable BS and single band tests, repeat the steps above per involved *operating band* where single band test configurations and test models shall apply with no carriers activated in the other band.

For extreme conditions tests the methods in annex B.7 may be used.

This ambiguity in TR 37.941 [1] may be solved by using the same wording already used in TS 38.141-2 [2]. An example of the change is presented in Annex A to this contribution.

**Proposal:** implement the changes in Annex A for all measurement procedures in TR 37.941 where this ambiguity can be found.

# References

1. R4-2002430, “Big TP for TR 37.941, Rel-15”, Huawei, RAN4 #94-e, February 2020
2. 3GPP TS 38.141-2 v16.2.0 (2019-12)

# Annex A – Proposed change to TR 37.941

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9.2.2.2.2 Stage 2: BS measurement

The testing procedure consists of the following steps:

1) Uninstall the reference antenna and install the BS with the manufacturer declared coordinate system reference point in the same place as the phase centre of the reference antenna. The manufacturer declared coordinate system orientation of the BS is set to be aligned with the testing system.

2) Set the BS to generate the tested beam with the *beam peak direction* intended to be the same as the testing direction.

3) Rotate the BS to make the testing direction aligned with the direction of the receiving antenna.

4) Set the BS to transmit the test signal at the maximum power according to applicable test model.

5) Measure the mean power for each carrier arriving at the measurement equipment connector, denoted by PR\_EIRP, D, which is defined as measured mean power for each carrier at the measurement equipment connector at the reference point D in figure 7.2.1-1.

6) Calculate the EIRP with the following formula:

EIRP = PR\_EIRP, D + LEIRP\_cal, A→D

7) Calculate total EIRP = EIRPp1 + EIRPp2 where the declared beam is the measured signal for any two orthogonal polarizations (denoted p1 and p2).

8) Repeat the above steps 2 - 7 per conformance test *beam direction pair*.

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9.2.3.2.2 Stage 2: BS measurement

The testing procedure consists of the following steps:

1) Set up BS in place of SGH from calibration stage. Align BS with *beam peak direction* of range antenna.

2) Configure TX branch and carrier according to maximum power requirement and test configuration.

3) Set the BS to transmit the test signal according to applicable test model.

4) Measure mean power (Pmeas) of each carrier arriving at the measurement equipment (such as a spectrum analyzer or power meter) denoted in figure 8.3-1.

5) Calculate EIRP, where EIRP = Pmeas + LA→B.

6) Calculate total EIRP = EIRPp1 + EIRPp2 where the declared beam is the measured signal for any two orthogonal polarizations (denoted p1 and p2).

7) Repeat steps 2 - 6 for all conformance test *beam direction pairs*.

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9.2.4.2.2 Stage 2: BS measurement

The testing procedure consists of the following steps:

1) Connect the receive network of the compact probe to the measurement equipment.

2) Calibrate the test range, using a reference antenna with standard gain installed in the quiet zone of the probe and measure the path loss between reference antenna and the measurement equipment.

3) Install the BS in the quiet zone of the probe with its manufacturer declared coordinate system reference point in the same place as the phase centre of the reference antenna. The manufacturer declared coordinate system orientation of the BS is set to be aligned with testing system.

4) Align with the required conformance steering directions.

5) Set the BS to transmit at maximum EIRP appropriate to conformance steering directions according to the manufacturer declaration.

6) Measure the received power at the probe and thus the EIRP of the BS.

7) Calculate total EIRP = EIRPp1 + EIRPp2 where the declared beam is the measured signal for any two orthogonal polarizations (denoted p1 and p2).

8) Repeat test steps 2 - 7 for all declared beams and corresponding conformance steering directions.

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9.2.6.2.2 Stage 2: BS measurement

The testing procedure consists of the following steps:

1) Install the BS with the manufacturer declared coordinate system reference point in the same place as the phase center of the reference antenna A as shown in figure 7.6.1-1. The manufacturer declared coordinate system orientation of the BS is set to be aligned with the testing system.

2) Set the BS to generate the tested beam with the applicable test model with the *beam peak direction* intended to be the same as the testing direction.

3) Measure mean power (Pmeas) at the measurement equipment (such as a spectrum analyzer or power meter) denoted in figure 9.2.6.2.2-1.

4) Calculate EIRP, where EIRP = Pmeas + LC→A.

5) Calculate total EIRP = EIRPp1 + EIRPp2 where the declared beam is the measured signal for any two orthogonal polarizations (denoted p1 and p2).

6) Repeat steps 2 - 5 for all conformance test *beam direction pairs* and test conditions.

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9.4.2.2.2 Stage 2: BS measurement

The testing procedure consists of the following steps:

1) Uninstall the reference antenna and install the BS with the manufacturer declared coordinate system reference point in the same place as the phase centre of the reference antenna. The manufacturer declared coordinate system orientation of the BS is set to be aligned with the testing system.

2) Set the BS to generate the tested beam with the *beam peak direction* intended to be the same as the testing direction.

3) Rotate the BS to make the testing direction aligned with the direction of the receiving antenna.

4) Set the BS to transmit the test signal at the maximum power according to applicable test model.

5) Measure the PDL\_RS, which isthe measured signal power of DL RS EIRP (in the *beam peak direction*).

6) Calculate the EIRPDL\_RS with the following formula:

EIRPDL\_RS = PDL\_RS + LTX\_cal, A→D

and

EIRPDL\_RS = EIRPDL\_RS\_p1 + EIRPDL\_RS\_p2 where the declared beam is the measured signal for any two orthogonal polarizations (denoted p1 and p2).

7) Repeat steps 2 - 6 for all conformance test *beam direction pairs* and test conditions.

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9.4.3.2.2 Stage 2: BS measurement

The testing procedure consists of the following steps:

1) Set up BS in place of SGH from calibration stage. Align BS with *beam peak direction* of range antenna.

2) Configure TX branch and carrier according to maximum power requirement and test configuration.

4) Set the BS to transmit the applicable test signal.

5) Measure the PDL\_RS which isthe measured signal power of DL RS EIRP (in the *beam peak direction*).

6) Calculate EIRPDL\_RS using the following equation:

EIRPDL\_RS\_p(x) = PDL\_RS\_meas + LA→B.

And

EIRPDL\_RS = EIRPDL\_RS\_p1 + EIRPDL\_RS\_p2 where the declared beam is the measured signal for any two orthogonal polarizations (denoted p1 and p2).

7) Repeat steps 2-6 for all conformance test *beam direction pairs* and test conditions.

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9.5.2.2.2 Stage 2: BS measurement

Reference procedure in subclause 6.4.2.2.2 where in step 6 the appropriate measurement is:

The appropriate test parameter in step 6 for the output power dynamics vary depending on the specific measurement as described for the conducted measurement in TS 37.145-1 in each case however the EIRP measurement is made on both polarisations and added as follows:

EIRPmeas\_p(x) = Pmeas\_p(x) + LA→B

and

EIRPmeas = EIRPmeas\_p1 + EIRPmeas\_p2

where the declared beam is the measured signal for any two orthogonal polarizations (denoted p1 and p2).

Furthermore, the measurement is performed twice; once with the BS transmitting at Prated,c,EIRP on all PRBs and then a second time with the BS transmitting on a single PRB. Both measurements are made in the same conformance direction in the same calibrated test setup. The ratio of these two EIRP levels is used to assess compliance for the OTA total power dynamic range.

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9.5.3.2.2 Stage 2: BS measurement

Reference procedure in subclause 6.4.3.2.2 where in step 6 the appropriate measurement is:

The appropriate test parameter in step 6 for the output power dynamics vary depending on the specific measurement as described for the conducted measurement in each case however the EIRP measurement is made on both polarisations and added as follows:

EIRPmeas\_p(x) = Pmeas\_p(x) + LA→B.

and

EIRPmeas = EIRPmeas\_p1 + EIRPmeas\_p2

where the declared beam is the measured signal for any two orthogonal polarizations (denoted p1 and p2).

Furthermore, the measurement is performed twice; once with the BS transmitting at Prated,c,EIRP on all PRBs (in case of NR) and then a second time with the BS transmitting on a single PRB. Both measurements are made in the same conformance direction in the same calibrated test setup. The ratio of these two EIRP levels is used to assess compliance for the OTA total power dynamic range.

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