2x2 MIMO Downlink OTA Measurement based on CTIA Guidelines

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***Abstract*—Wireless industry through 3G Partnership Project (3GPP), and CTIA The Wireless Association has been studying, validating, and standardizing the 2x2 MIMO Downlink OTA tests since 2009. Especially, CTIA has already provided the guidelines for the MIMO OTA tests in both the Spatial Multiplexing, and Transmit Diversity scenarios [1]. After highlighting some background of the well-documented Spatial Fading Emulation Technique [3-4-5] in which an array of eight dual polarized antennas and a fading Emulator is used, the paper is presenting the MIMO OTA results of a testing campaign. The Absolute Throughput is the Figure of Merit for MIMO OTA and it has been measured versus both the power and the SIR (Signal to Interference Ratio) at the DUT (device under test) location. It has also been reported in a way that a visual representation of the DUT behavior as a function of the azimuth rotation is given.**

I. INTRODUCTION

Wireless Industry through 3GPP and CTIA standardization bodies have been studying, and evaluating different methodologies for the 2x2 MIMO Downlink OTA conformance testing [1-2]. Especially, CTIA has provided the guidelines for the MIMO OTA tests in the spatial multiplexing (TM3) mode, and also the tests for the transmit diversity (TM2) mode [1]. The Spatial Fading Emulation technique has been selected as the methodology for MIMO OTA tests due to mainly the nature of the propagation model which can be emulated in such environment [3-4-5]. Generally speaking, the setup is composed of N transmitting probes placed on a horizontal ring, and a spatial fading emulator in order to emulate the complex RF environment at the DUT location [3-4-5]. This setup has been fully validated and the results of the results of the validation activities have been peer-reviewed and agreed to be included in the 3GPP TR 37.977 v 13.0 [2].

This paper is presenting the MIMO OTA performances of three different LTE devices supporting the Bands 2, 4, and 13. The Throughput has been reported versus the total power, and the SIR at the DUT location. A visual inspection of the DUT performances versus the azimuth rotation of the DUT is also reported.

II. SPATIAL FADING EMULATION TECHNIQUE

The system overview is shown in Figure 1:

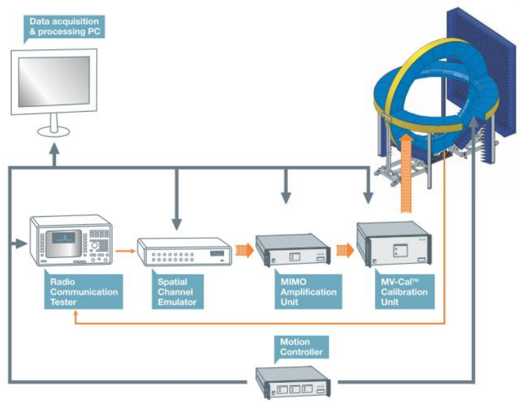

Fig. 1. MVG StarMIMO system setup

One of the key feature, and advantage of the MVG StarMIMO setup is the allowance of using self-calibration routine for calibrating the setup. The calibration is aiming of equalizing each path in amplitude and phase at the DUT location. Adding switching units to the outputs of the Amplification Unit is creating a connection between the CW signal generator (usually the Radio Comm. Tester itself), and the receiver (usually a Vector Network Analyzer). This way, the array of probes and all the passive elements inside the chamber are by passed and a calibration of the active components outside the anechoic environment can be done without physically changing the setup. It is why this configuration can develop self-calibration routine with a minimum interference from the system operator and hence not introducing uncertainty to the final result.

III. TESTING RESULTS

A set of three devices supporting LTE 2x2 MIMO downlink technology in three different bands, 2 (1960MHz), 4 (2132.5MHz), and 13 (751MHz) have been tested.

The device is rotated in Azimuth with a step of 30deg and the throughput is measured from 100% to 70% of the maximum theoretical throughput (based on the Fixed Reference Channel used) with a power step of 0.2dB from 95% throughput to 70%. SCME Urban macro is used as propagation model as required in [1].

A. Throughput Versus Power

In figure 2 the throughput versus power for each azimuth rotation is shown:

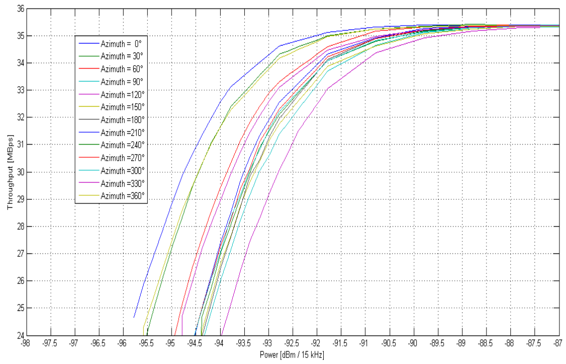

Fig. 2. Throughput Vs power for each azimuth rotation

The average throughput has been then calculated and in figure 3 the average throughput versus power is reported for both the mechanical modes tested, Portrait and Landscape:

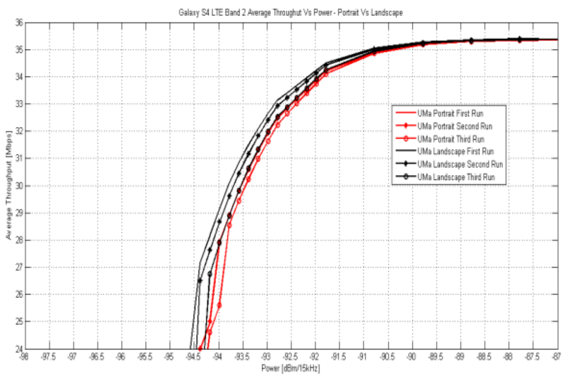

Fig. 3. Average Throughput Vs power – Portrait Vs Landscape

B. Throughput Versus SIR

Omni directional (AWGN) noise has been added to the LTE signal power. The noise can be added to each output of the fading emulators so that a specific Signal to Interference ratio (SIR) can be emulated at the DUT location. In Figure 4 the average throughput versus SIR is shown for both the mechanical modes:

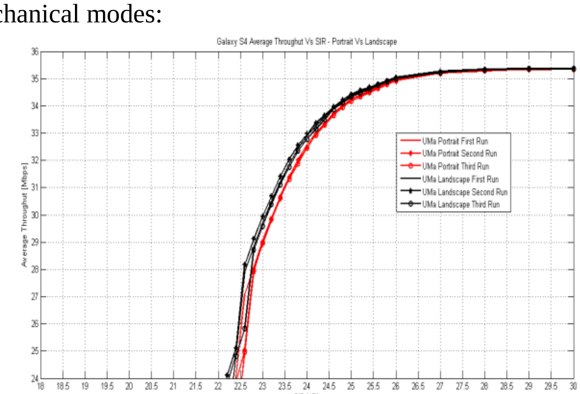

Fig. 4. Average Throughput Vs SIR – Portrait Vs Landscape

C. Device Performance Versus Azimuth Rotation

Effective Throughput Power Sensitivity (ETPS) is defined as the power [dBm/15kHz] required to achieve either the 95% or 70% of the maximum throughput for each azimuth rotation. ETPS Vs DUT rotation can indicate the degree of uniformity of the DUT MIMO performances as a function of the azimuth rotation. The same assumption is valid when SIR is considered. In figure 5, and 6 the device performance respectively in terms of power and SIR versus azimuth rotation are reported for the Portrait mechanical mode:

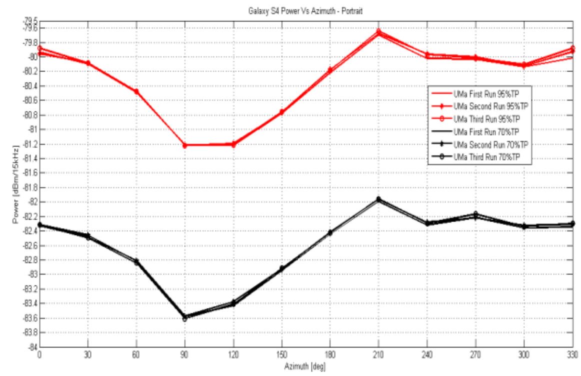

Fig. 5. Power Vs Azimuth rotation

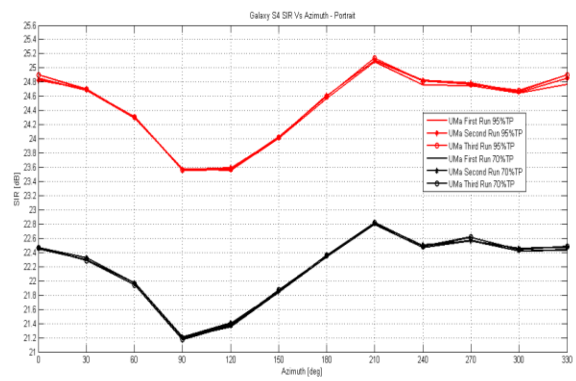

Fig. 6. SIR Vs Azimuth rotation

IV. CONCLUSION

2x2 MIMO Downlink OTA test results have been shown. The CTIA guidelines were used for measuring three LTE reference devices. The DUT MIMO performances in terms of throughput have been also reported in a way that the uniformity of the DUT versus azimuth rotation is shown.

REFERENCES

[1] Draft CTIA Test Plan 2x2 MIMO Downlink and Transmit Diversity OTA Performances v 0.3, October 2014.

[2] 3GPP TR. 37.977 v 13.0, November 2013.

[3] A.Scannavini, L.J.Foged, et.al., "OTA Throughput Measurement by using the Spatial Fading Emulation Technique" EuCap2010.

[4] A.Scannavini, L.J.Foged, et.al., "MIMO OTA Testing using Multi Probe System Approach", EuCap2013.

[5] A.Scannavini, L.J.Foged, et.al., "OTA Measurement of Wireless Devices with Single and Multiple Antennas in Anechoc Chamber", EuCap2014.