Switched-beam Antenna for Small Cell Application

Chia-Lun Tang, Chun-Hua Chen
Wireless Communication BU, Auden Techno Corp., No. 19, Ln. 772, Heping Rd., Bade Dist., Taoyuan City 33463, Taiwan

Abstract **– This paper presents a switched-beam antenna for LTE/WWAN operation in Small Cell application. The proposed antenna consists of 5 sets high gain dual-polarized dipole antennas, and integrated a switching network circuit to form multiple beams to improve wireless communication performance.**

Index Terms **— Dual-polarized, dipole antenna, switched-beam, Small Cell**

1. Introduction

The global 4G wireless broadband communications market is booming now, many mobile carriers have deployed Small Cells in order to extend signal coverage and increase communication capacity. Currently, the Small Cell antennas are usually designed with a LTE multi-band operation and support MIMO antenna configuration. For the future, the multi-beam antenna technology will also import in Small Cells to increase the signal coverage and effectively to reduce interference to improve transmission data rate. In this article, different to the dual-polarized patch or dipole base station antenna applied in [1, 2], we demonstrate a novel 2 × 2 MIMO switched-beam antenna, integrate 5 sets of high gain dual-polarized dipole with switching network circuit for radiation beam forming for Small Cells application.

2. Dual-Polarized Dipole Antenna with U-shaped Metallic Reflector

Fig. 1 shows one set high gain dual-polarized dipole of switched-beam antenna array. The proposed antenna has a simple structure formed by two orthogonal wideband dipoles (antenna 1 is designed for +45° polarization, antenna 2 is designed for -45° polarization) and a U-shaped metallic reflector. The antenna radiator and feed are printed on a 1.0-mm-thick double-layer FR4 of size 101 × 40 mm^2 and RF signal connected via a coaxial cable with I-PEX connector. The wide resonant band is excited by a pair wide radiator arm of dipole with 9 mm width. The reflector is made by metal sheet and bent like a U-shaped structure to concentrate radiation pattern to enhance antenna gain and the size of reflector is 120 × 92 × 27.5 mm^3.

The simulated and measured VSWR, Isolation of the dual-polarized dipole antenna are presented in Fig. 2 and 3. The simulation results are simulated by using SEMCAD EM software tool [3], and are seen to agree with the measured results. The wide operating bandwidth is obtained covered from 1690 MHz to 2730 MHz, and the isolation between two orthogonal dipole antennas is seen to be less -22 dB over the operating band of 1710-2690 MHz.

Fig. 4 shows the simulated and measured antenna gain. The measured antenna gain is more than 7 dBi in average that is good for wireless communication application. The simulated and measured radiation patterns of the proposed antenna at 1710 MHz, 2145 MHz and 2690 MHz are shown in Fig. 5. A broadside radiation patterns are observed in horizontal plane, and the measured 3-dB beamwidth is around 70°, and front-to-back ratio is more than 13 dB when adding the U-shaped metallic reflector.

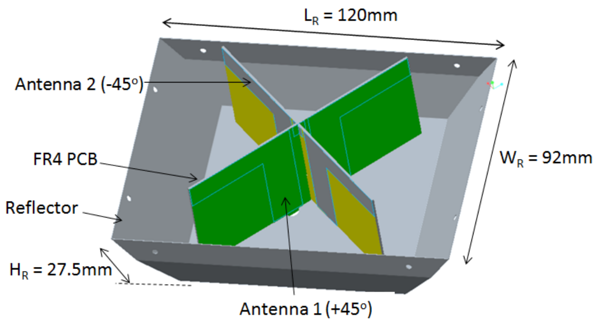

Fig. 1. Geometry of the proposed dual-polarized dipole antenna with U-shaped metallic reflector.

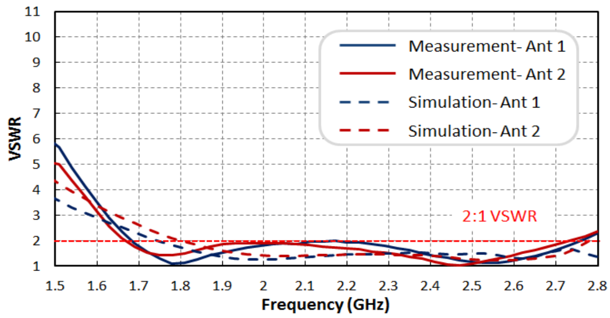

Fig. 2. Simulated and measured VSWR of the dual-polarized dipole antenna.

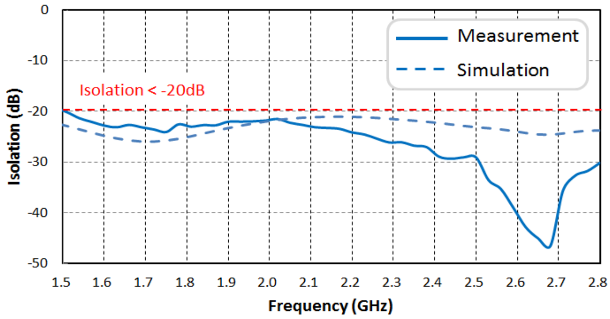

Fig. 3. Simulated and measured isolation of the dual-polarized dipole antenna.

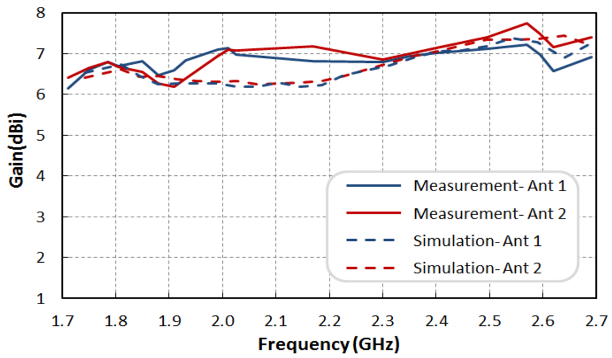

Fig. 4. Simulated and measured antenna gain of the dual-polarized dipole antenna.

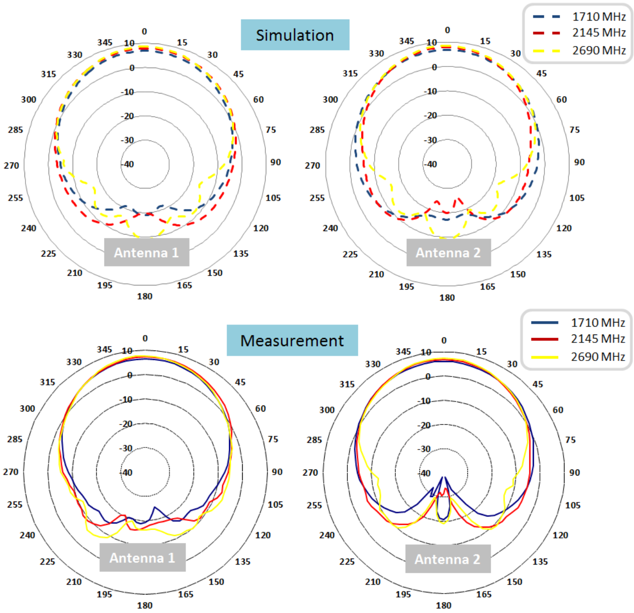

Fig. 5. Simulated and measured radiation patterns of the proposed antenna in the horizontal plane at 1710 MHz, 2145 MHz and 2690 MHz.

3. Switched-beam Antenna Array

Fig. 6 shows the geometry and photo of the proposed switched-beam antenna array. 5 sets dual-polarized dipole antennas are integrated back-to-back to be a pentagon shape antenna array and the whole antenna size is 200 × 200 × 92 mm^3. There are two RF ports from the proposed antenna and can support 2 × 2 MIMO system, one RF port performs +45° polarization, and the other performs -45° polarization. Each polarization antenna array has 31 radiation pattern selections by tuning switching network circuit. Fig. 7 shows the radiation patterns in horizontal plane with different antenna array combination. It is obviously seen the single directional radiation is obtained when only select one antenna on, and multi directional or wider coverage pattern are obtained when select more than one antennas on. So use the proposed switched-beam antenna can efficiently improve wireless communication quality by selecting optimized radiation pattern, when the Small Cells are applied in different environments or user scenarios.

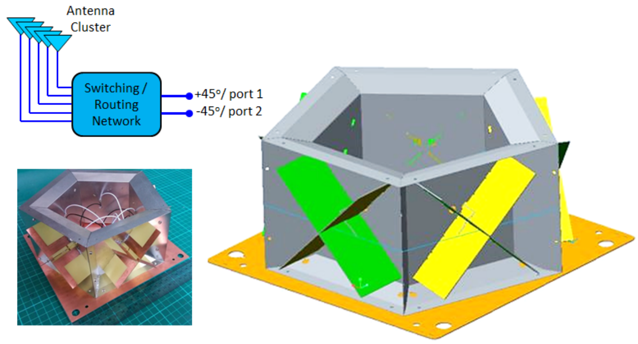

Fig. 6. Geometry of the switched-beam antenna array for LTE small cell application.

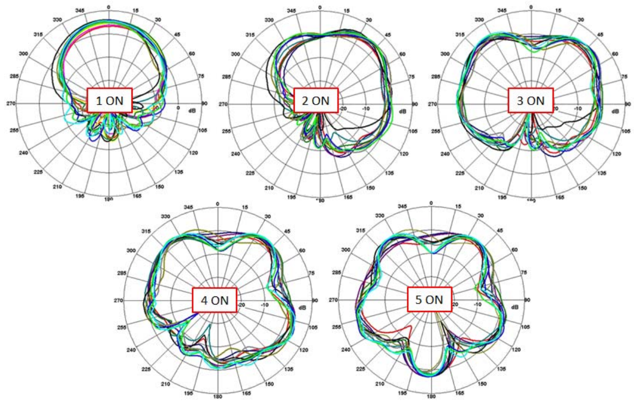

Fig. 7. Measured horizontal radiation patterns of the switched-beam antenna array in different switching state.

4. Conclusion

In this paper, a high gain dual-polarized dipole antenna is proposed, and combine 5 sets dipole antennas with switching network circuit to be switched-beam antenna, and the antenna array size is 200 × 200 × 92 mm^3. The proposed antenna has a wide bandwidth for LTE/WWAN operation in 1710-2690 MHz band. Good radiation performance is obtained in horizontal plane, and has 31 radiation pattern selections for each polarization and support 2×2 MIMO system. Experimental results show the proposed antenna will be promising for practical Small Cell applications.

References

[1] Y. X. Guo, K. M. Luk and K.F. Lee, "Broadband dual polarization patch element for cellular-phone base stations," *IEEE Trans Antennas Propag.*, vol.50. no.2, Feb. 2002.

[2] J. N. Lee, K. C. Lee, G. D. Jo, H. K. Kwon, B. S. Kang, J. H. Oh, M. D. Kim and N. H. Park, "Design of the Dual-polarized Dipole Antenna for Small Base Station," *ISAP*, pp.1059-1060, 2012.

[3] SEMCAD, Schmid and Partner Engineering AG (SPEAG), Available at http://www.semcad.com.