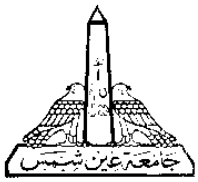


AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics Engineering and Electrical Communications

Multi-Antenna Solutions for Long Term Evolution (LTE) Advanced

A Thesis submitted in partial fulfillment of the requirements of the degree of

Master of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

By

Ahmed Abdelsamad Abdelmonem Asaker

B.Sc. of Electrical Engineering

Electronics Engineering and Electrical Communications

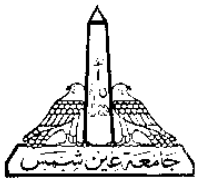
Faculty of engineering, Al-Azhar University, 2008

Supervised By

Prof. Dr. Abdelhalim Abdelnapi Zekry

Dr. Reda Salama Ghoname

Cairo, 2015



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Date: 17 October 2016

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, faculty of Engineering, Ain Shams University.

The Author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Thesis Summary

This thesis presents an antenna design which can be used in LTE-A applications. Initially, describe the analysis and design of the single element microstrip antenna. The bandwidth of the conventional patch is enlarged by using etched slots at the antenna patch to cover the LTE-A uplink frequency band range from 2.5 up to 2.57 GHz as of today's standard based on 36.101 Table 5.5-1 (March 2012). The designed antenna has been fabricated by using thin film and photolithographic technique and has been measured by using the Vector Network Analyzer. The simulated and measured results were found to have good match with each other. The total area of the fabricated single element antenna is (60mm*50mm).

Then using the designed single-element antenna, a two - element MIMO system has been designed employing polarization diversity. The minimum separation between antenna elements to be decoupled equals $0.13\lambda_{\circ}$. This separation is smaller compared to the conventional arrays which should be separated by $0.5\lambda_{\circ}$ where $\lambda_{\circ}$ is the free space wavelength.

In order to enhance the isolation between the microstrip elements, different decoupling methods based on various mechanisms have been studied for the proposed two-element MIMO antenna system. First technique is to place a designed rectangular metal-structure between the two spaced polarized MIMO antenna elements. The second method is to cut a simple rectangular slot in the ground plane centered between the two spaced polarized microstrip antenna elements. The third method is to introduce narrow, closely spaced rectangular slots in the ground plane centered between the two microstrip elements.

In the proposed decoupling method, a combination of the first and second methods has been employed resulting in a significant reduction of the mutual coupling across antenna operating frequency band.

By using the proposed decoupling method, the separation between the microstrip elements was reduced to be $0.075\lambda_{\circ}$ rather than $0.13\lambda_{\circ}$ without missing decoupling between antenna elements.

Using the designed single-element antenna, a four-element MIMO antenna system which is supported by LTE-A uplink frequency band, has been built employing polarization diversity.

By using the same techniques as for the two-elements MIMO array, metal structures are placed between antenna elements as well as modifying the ground plane, a significant reduction of the mutual coupling and maximum miniaturization of antenna array have been observed. The total area of the MIMO array is 100mm*100mm.

A ready-made software package (CST microwave studio and measurement) is used for simulation. A four-element MIMO antenna was fabricated by using the same substrate and techniques of single-element antenna. Finally, good agreement between the simulated and measured results was found to meet our goals for LTE-A Uplink band "CA-B7" as of today's standard based on 36.101 Table 5.5-1 (March 2012) [10].

Key words: Microstrip antennas, SISO systems, MIMO systems, polarization diversity, LTE-A, Mutual coupling, Slotted ground plane "SGP", Isolating metal structure.

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