MIMO Antenna System of a Compact 4-element PILA for 4G Handset Applications

[1]Saqer S. Alja'afreh
Electrical Engineering Department
Mu'tah University
Alkarak, Jordan
Saqer1981@yahoo.com

[2]Yi.Huang
Department of Electrical Engineering & Electronics
University of Liverpool
Liverpool, United Kingdom
Yi.Huang@liv.ac.uk

[3]Qian. Xu, [3]Lei. Xing
Department of Electrical Engineering & Electronics
Nanjing University of Aeronautics and Astronautics
Nanjing, China
emxu@foxmail.com, xinglei@nuaa.edu.cn

[4]Omar. A Saraereh
Department of Electrical Engineering
The Hashemite University
Zarqa, Jordan
eloas2@hu.edu.jo

Abstract—**A compact multiple input multiple output (MIMO) antenna system of four-element planar inverted-L antenna (PILA). The antenna elements are installed along the corners of a PCB board. To mitigate the mutual coupling effect, compact parasitic decoupling elements are used between elements. The design covers a very wide 6dB return loss bandwidth (1700-3500 MHz) with isolation level better than 10 dB. Both simulated and measured results are obtained, and the results demonstrate that the proposed antenna is a very good candidate for mobile diversity and multiple-input and multiple-output (MIMO) applications in recent 4G systems.**

Keywords-component;Parasistic Decoupling Element, 4G, MIMO, PILA, Diversity Antenna.

I. INTRODUCTION

As multiple inputs multiple outputs represents one of the key technologies for the recent 4G wireless and mobile communication systems, the design of multiple antenna system has attracted the research attention. Also, the upcoming 5G system is expected to be launched in 2020, it will require a massive MIMO antenna system (more antenna elements) is to be installed at both the mobile devices and the base stations [1]. This new technology raises the challenges in finding a compact and universal multi-antenna system for small handset devices.

The literature includes a huge number of dual-element MIMO antennas for small handset devices [2], but the used of four-element MIMO antennas is not widespread yet. Even the published designs, some of them were narrowband or single band designs for frequency applications higher than 2 GHz [3-5]. Others were not suitable for handset integration as they utilized the ground plane for both radiating elements and isolation circuitry [6-9]. In [10], a very small footprint planar inverted-L antenna has been presented for wideband handset applications (1700-2850) MHz; the work is continued toward a dual-element PILA in [11]. However, the number of elements and the compactness can be furthered improved. In this paper, a wideband (1700-3500) MHz four-element MIMO PILA antenna is developed for 4G mobile standards. Instead of one antenna element, two antenna elements are used on each edge of the PCB (top and bottom edges). The isolation is achieved between the elements on the same edge by creating a compact parasitic decoupling element; the compactness of the structure is achieved via elements bending. In Section II, the geometry of the proposed design is presented. Then, the antenna system performance include the S-parameters, radiation patterns, total radiation efficiency, envelope correlation coefficient and the diversity gain are all presented in Section III. Finally some conclusions are drawn in Section IV.

II. ANTENNA DESIGN AND PROPPOSED ISOLATION STRUCUTRE

The geometry and design parameters of the proposed four-element antenna system are shown in Fig. 1. The antenna system consists of four planar inverted-L antenna (PILA) elements placed on the corners of 55 x 100 x 1.5 mm^3.grounded FR-4 substrate. Two elements lie on the upper edge while the other two placed on the lower edge of the PCB substrate. By deploying both inductive loading (meandering) and capacitive loading (bending), the radiating elements are made small as possible [11].

At the beginning, the four-elements are arranged without a decoupling circuitry. Fig. 2 shows that the design can cover around 1 GHz bandwidth (based on the 6-dB return loss bandwidth), but the level of the mutual coupling between elements on the same short edge (S12 and S34) is high.

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