

# Low Correlation Multiple Antenna System for Mobile Phone Applications Using Novel Decoupling Slots in Ground Plane

Omar A. Saraereh

Department of Electrical Engineering  
The Hashemite University  
Zarqa, Jordan  
eloas2@hu.edu.jo

C. J. Panagamuwa and J. C. Vardaxoglou

School of Electronic, Electrical and Systems Engineering  
Loughborough University  
Loughborough, UK  
c.j.panagamuwa@lboro.ac.uk

**Abstract**—A compact low profile multiple antenna system for multiple-input-multiple-output (MIMO) applications is proposed. The antenna system combines two monopole type printed antennas with a slotted ground plane for low correlation and high isolation characteristics. The main antenna covers the twelve wireless communication bands required for LTE, GSM, UMTS2110, Bluetooth, WiMAX and WLAN. The auxiliary antenna has a very small volume compared to the main one and covers the ultra-wideband (UWB) frequency range (3.74-12 GHz). The antennas are positioned at opposite ends of the system's ground in order to reduce the mutual coupling between them. The isolation maintained is better than 20 dB over the desired frequency bands, resulting in an envelope correlation coefficient of less than 0.08. The simulation results show good S-parameters, high gain and radiation efficiency, and relatively stable radiation patterns. Due to the compact size and the ultra-wide bandwidth, the proposed multiple antenna system is suitable for communication handsets that have size limitations. Results are presented and discussed.

**Keywords**—mobile antenna; MIMO; correlation; mutual decoupling; LTE; planar monopole; slotted ground; multiband.

bands LTE700/GSM850/GSM900 due to their strong mutual coupling.

In this paper, a novel multiple antenna system for mobile handset applications is proposed. It covers standards LTE700/2300/2500, GSM 850/900/1800/1900, UMTS2110, ISM/Bluetooth, WiMAX 2500/3500, WLAN2400/5200/5800 and UWB in the frequency range (3.74-12 GHz) at return loss better than 6 dB simultaneously. The antennas can also be used for MIMO operations.

## II. MULTIPLE ANTENNA SYSTEM STRUCTURE

The proposed multiple antenna system design comprising two antennas are denoted through this paper as main antenna and auxiliary antenna. Both encompass coupled-fed elements and monopole type antennas. Fig. 1(a), (b) and (c) show the geometry details and dimensions of the proposed antenna system. The presented antenna arrangement consists of main antenna, auxiliary antenna, system PCB (substrate), protruded slotted ground plane and two feeding ports. The main ground is printed on a 0.8 mm thick FR-4 substrate ( $\epsilon_r=4.4$  and loss tangent is 0.02) of total size  $50 \times 120 \text{ mm}^2$ . The dimensions of the PCB and the ground size considered