Design of a Hexa-band Antenna for Mobile Devices

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1. Introduction

One of the most common antenna design for mobile devices is planar inverted-F antenna (PIFA) design [1-3], which normally covers the quad-band operation such as global system for mobile communication (GSM, 890-960 MHz), digital communication system (DCS, 1710-1880 MHz), personal communication system (PCS, 1850-1990 MHz), and universal mobile telecommunication system (UMTS, 1920-2170 MHz). Although this antenna design is attractive for achieving multi-band and broadband operations; however, it requires a top radiating patch that locates above the system ground plane, with a height commonly fixed at around 6 mm, thereby potentially increasing the thickness of the mobile devices. With the rapid growth in mobile communications, it is not until recently that dual-network system applications such as the wireless local-area network (WLAN) and worldwide interoperability for microwave access (WiMAX) are also being considered to incorporate into the mobile devices [4-5]. Hence, in this paper, a hexa-band internal printed co-planar antenna is proposed due to the advantages such as low-profile and easy to fabricate at low cost. Besides the ability to cover the usual GSM/DCS/PCS/UMTS band, the proposed antenna also includes the dual-network band operating at WLAN (2400-2480 MHz) and WiMAX (2500-2690 / 3400-3600 MHz). Details of the antenna design are described, and the measured results of all fabricated prototypes are presented and discussed.

2. Antenna Design

The geometry of the proposed internal printed co-planar monopole antenna fabricated on a single side of a FR4 substrate is depicted in Figure 1, showing a simple CPW-fed design occupying a small area of 50 × 16 mm^2. Note that the lower left corner of the rectangular-shaped radiating element is linked back to the lower co-planar ground plane along the isolation slit, which in turn shorted to the circuit ground plane of 99 × 50 mm^2. Two slits, slit 1 and slit 2, of length 21.5 and 25.5 mm, respectively, are embedded parallel to each other on the radiating element. Impedance matching can be achieved by tuning the gap distance between the radiating element and the CPW ground plane, which in this case is 2 mm.

3. Experimental Results and Discussion

The fabricated prototype antennas are initially studied by using the simulation software, and since the measured return loss results are well related to the simulated one, only the measured data is presented in Figure 2. In this figure, it demonstrates that the proposed antenna is stemmed from studying prototype A antenna (without embedding slits 1 and 2), which can excite a triple resonant modes at 960, 2250, and 3571 MHz. Besides these 3 resonant modes, if only slit 2 is embedded (prototype B), an additional mode at 1813 MHz will be stimulated due to the current distribution along this slit, and if only slit 1 is loaded (prototype C), an additional mode at around 1900 MHz will also be excited. Hence, by loading both the slits onto prototype A, the proposed antenna is formed and interestingly, improvement in impedance matching are observed for the lower (GSM) and upper (WiMAX, 3.5 GHz) band centred at 955 and 3353 MHz, respectively, with a measured bandwidth of 210 and 753 MHz along 3:1 VSWR. As for the middle band for DCS/PCS/UMTS/WLAN/WiMAX (2.6 GHz) operation, a 1100 MHz bandwidth centred at around 2215 MHz is achieved due to combination of the 3 resonant modes, although the current distribution along slit 1 has caused a slight perturbation on the 2250 MHz mode. Figures 3 and 4 present the measured radiation characteristics of the proposed antenna at 2 principal planes at the centre frequencies of GSM, DCS, PCS, WLAN and WiMAX bands. Since the pattern for UMTS is similar to the DCS/PCS band, it is not presented here. The measured peak gain variation for all operating bands of the proposed antenna is presented in Figure 5, showing a stable gain variation of less than 2 dB.

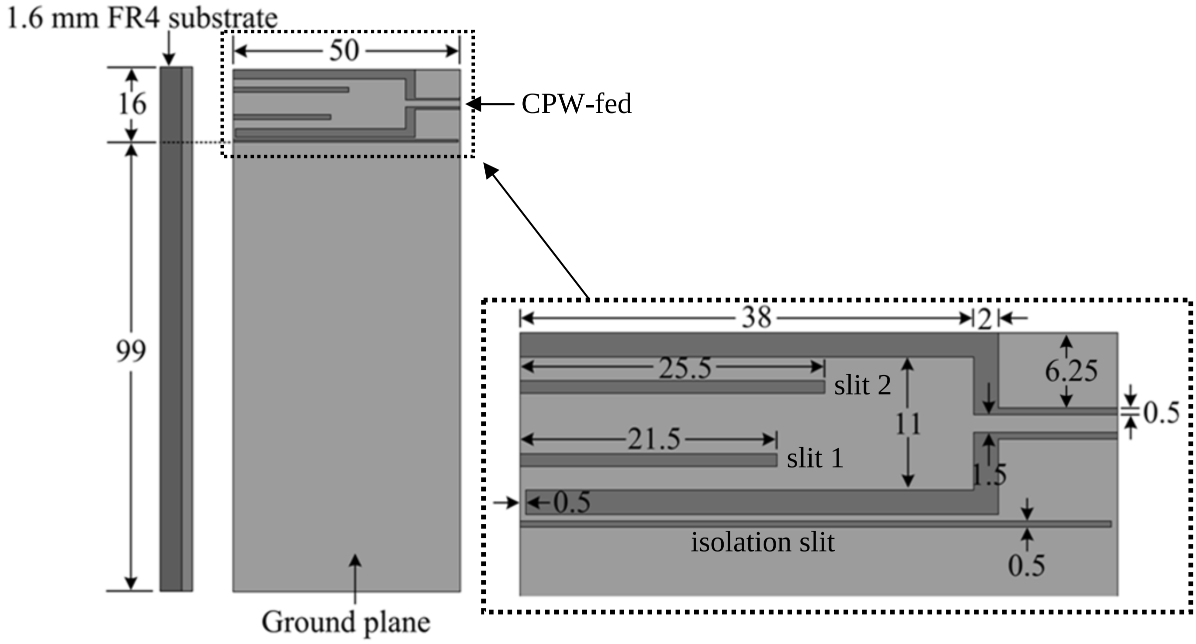

Figure 1: Geometry of the proposed internal printed CPW-fed hexa-band antenna

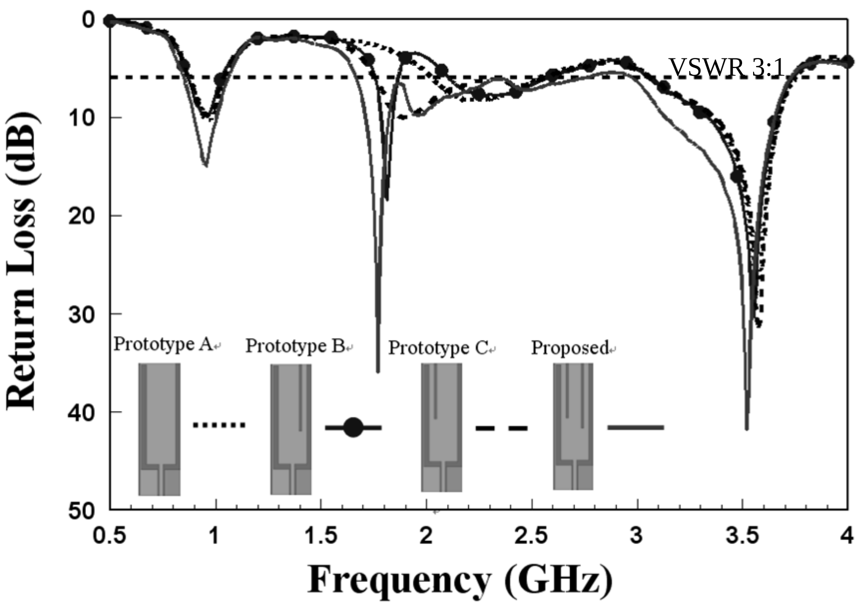

Figure 2: Measured return losses of all fabricated prototypes

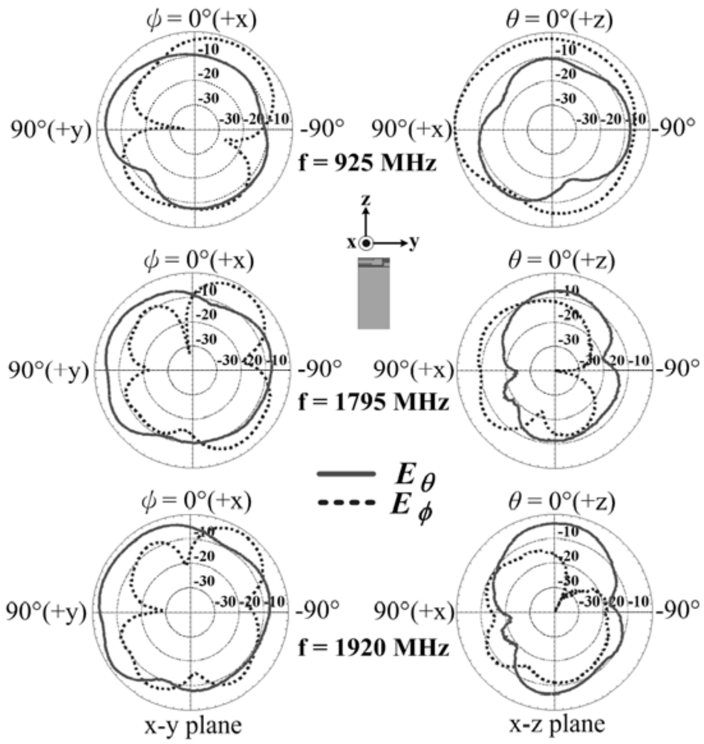

Figure 3: Measured radiation patterns for GSM, DCS, and PCS band

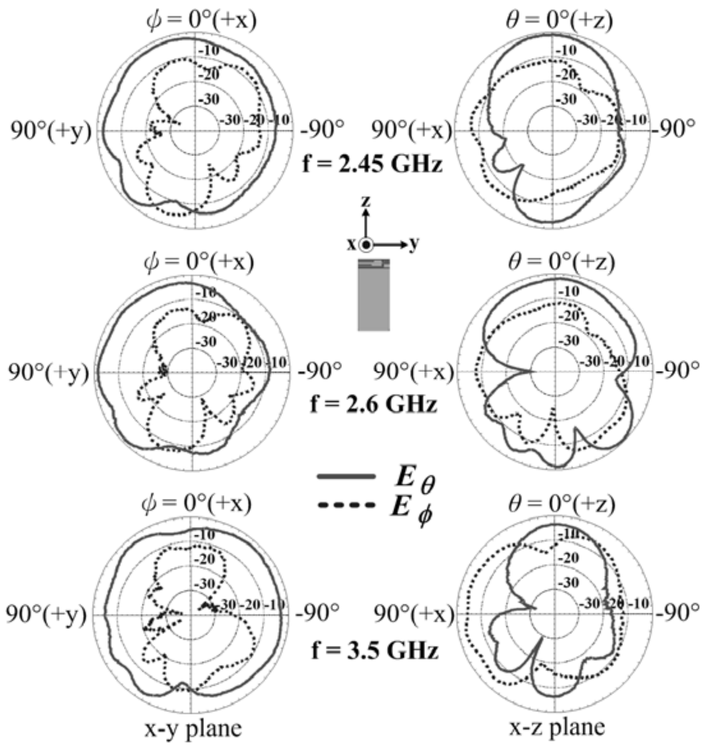

Figure 4: Measured radiation patterns for WLAN and WiMAX (2.6/3.5 GHz) band

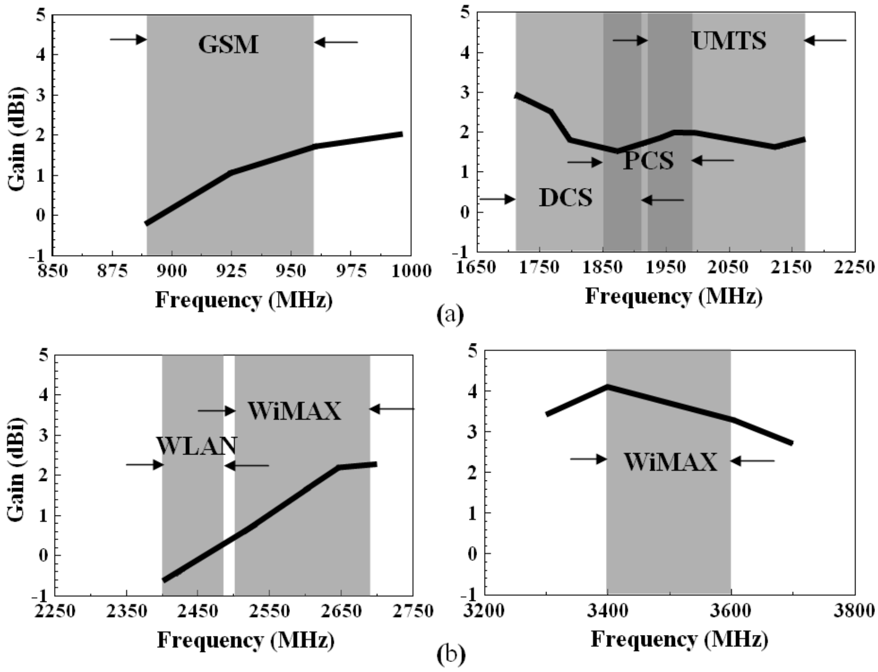

Figure 5: Measured peak gain variation of the proposed antenna for (a) GSM/DCS/PCS/UMTS, and (b) WLAN/WiMAX

References

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