Microstrip Line Fed Planar Monopole Antenna for Multiband Operation

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1. Introduction

Currently, development of wireless communications is rapidly expanding, which leads to the requirement of using a single antenna to cover multiple applications for mobile devices. For these applications, triple or multiband planar monopole antennas are very suitable since they are compact, low profile and easy to fabricate. Recently, many multiband antenna researches have been widely investigated for wireless applications at this aim [1-2] .In addition, a dual-band operation for the application in the wireless local area network (WLAN) communication systems has been successfully designed [3-5]. The antenna properly incorporated with open-end slits on the ground plane has demonstrated for antenna performance improvement [6]. However, a multiband system is becoming necessary to provide more services including Universal Mobile Telecommunications System (UMTS) and personal communications system (PCS), wireless local area network (WLAN) 5.2GHz.

In this paper, we propose a planar monopole antenna with fixed slot cuts in the ground plane. The proposed antenna is not only compact in size but also capable for multiband operation such as PCS (1850–1990 MHz), UMTS (1920–2170 MHz), and WLAN (5150–5350 MHz). In addition, the proposed multiband antenna with relatively low profile is very suitable for multiband mobile communication systems. The experimental results and the details of the proposed antenna design are both presented and discussed.

2. Antenna Structure and Design

The proposed antenna design in this work is shown in Fig. 1. By using a 50-microstrip feed line, the proposed antenna is excited. As shown in Fig. 1, the ground plane is selected to be 29x46 mm^2 which can be suitable for practical mobile devices and is printed on the back of the substrate. The radiating element has compact dimensions of 8x29 mm^2 with a distance of 3.9 mm from the top of the ground plane and is printed on the front of a 0.8mm FR4 substrate with a relative permittivity of 4.4.

In this design, the proposed antenna is a simple design consisting of folded slot and rectangular slot at the radiating patch. The dimensions of the folded slot are shown in Fig. 1. The major effect of the folded slot provides the lower mode of the operating frequency. It can be seen that the longer length of the folded slot is much greater than the length of the rectangular radiating patch, which makes the fundamental resonant frequency of the proposed antenna greatly lowered. On the other hand, the shorter length of the rectangular slot (2.3x4.9 mm^2) in the proposed design is about 10mm, which is slightly less than a quarter wavelength of the operating frequency at 5.2 GHz. This difference is large due to the effect of the supporting FR4 substrate, which reduces the resonant

length of the radiating element. The additional branch 3.9mm between the ground plane and the radiating element is for tuning and affects the higher mode of the resonant frequency. Then, two open-end narrow slits located at the top edge of the ground plane have been employed to either improve gain performance or input impedance matching of the antenna at the various bands. The advantage of using of slot cuts in ground plane can provide the decreasing in size of the antenna or ground plane.

3. Simulations and Experimental Results

In the study, a prototype of the optimal design for multiband applications was constructed. The characteristic impedance of the antenna was measured by an HP8510C network analyzer. Fig. 2 represents the comparison of the measured and simulated return losses S_{11} against frequency. According to the Fig. 2, the simulation and measurement results have a difference because it might be fabrication error. From the experiment results, it is clearly seen that two operating bandwidths are obtained. The lower bandwidth can cover the PCS (1850–1990 MHz), UMTS (1920–2170 MHz) and the upper band can also cover the WLAN (5150–5350 MHz).The radiation characteristics of the proposed antenna have also been studied. Fig. 3 show plots of the measurement of the radiation patterns at 1.85 GHz. Other measurements of the radiation pattern at the operating frequency for the proposed antenna are shown in Figs. 4 and 5. The measured antenna gains at the three frequencies listed above are shown in Fig. 6.

4. CONCLUSION

A compact planar monopole antenna has been proposed for multiband operations. The proposed antenna occupies a small size of 29x11.9 mm^2 and can operate in three bands of PCS, UMTS, WLAN (5.2 GHz). Good antenna gains and radiation patterns have also been observed. In addition, the antenna is compact, efficient, easy and cost effective to manufacture. Therefore, the antenna is suitable for multiband communication applications.

References

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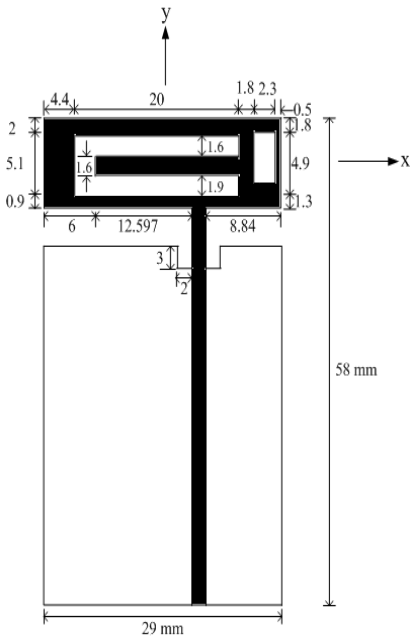


Figure 1: Proposed antenna's configurations with dimensions.

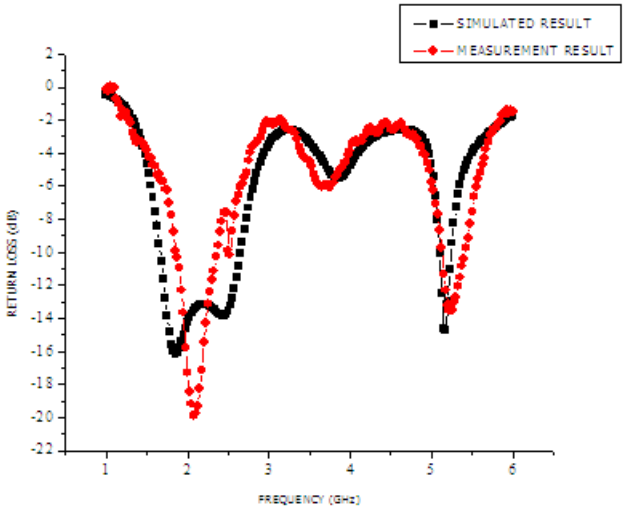
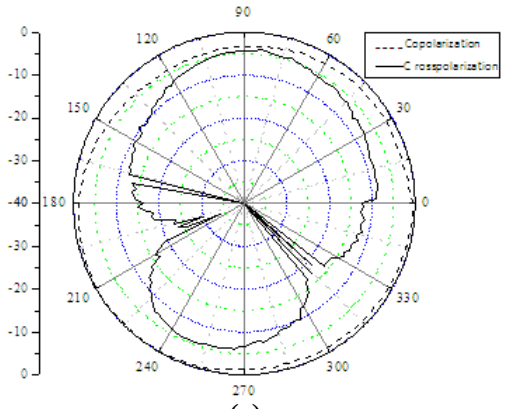
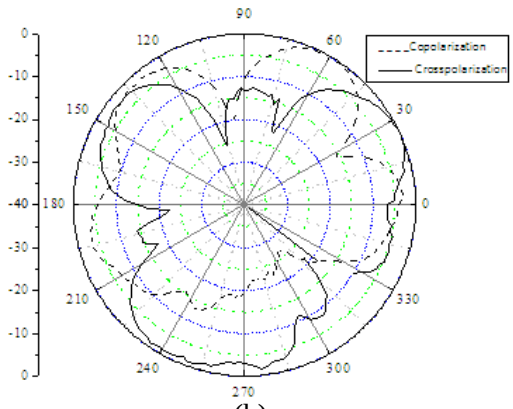


Figure 2: Measured and simulated return losses for the proposed antenna.



(a)



(b)

Figure 3: Measured radiation patterns of the proposed antenna at 1.85 GHz (a) XZ plane (b) YZ plane.

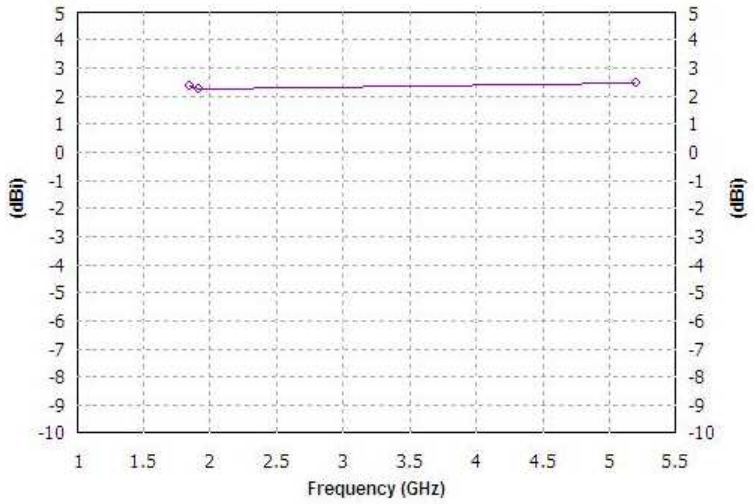
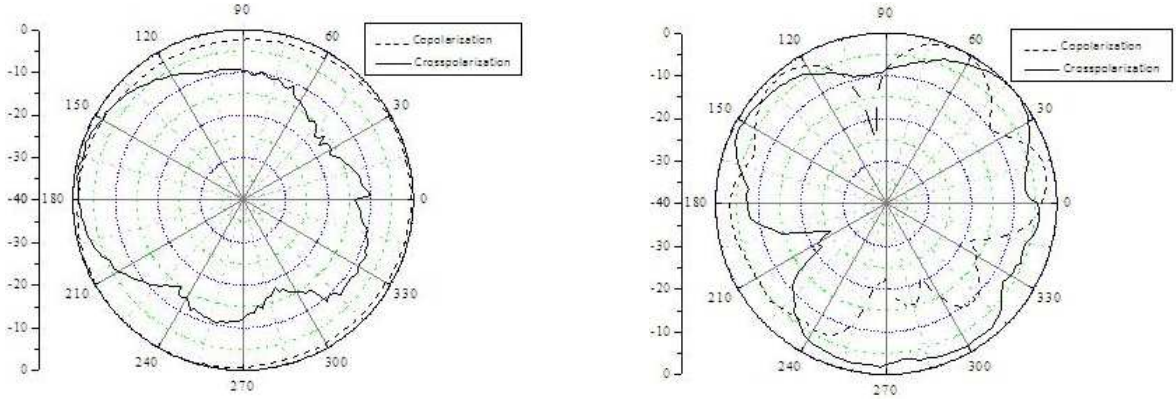
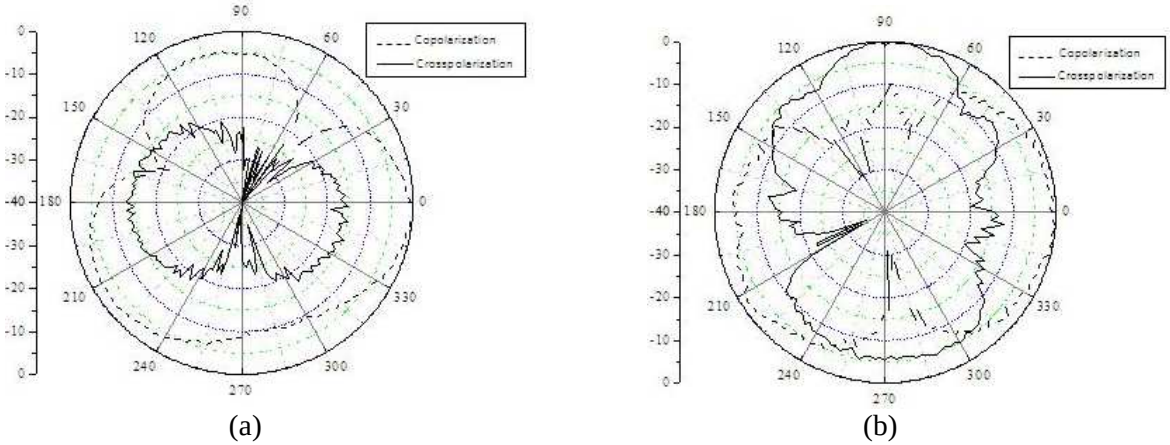


Figure 6: Measured antenna gain for the proposed antenna.



(a) (b)

Figure 4: Measured radiation pattern of the proposed antenna at 1.92 GHz (a) XZ plane (b) YZ plane.



(a) (b)

Figure 5: Measured radiation pattern of the proposed antenna at 5.2 GHz (a) XZ plane (b) YZ plane.