Reconfigurable Monopole Antenna for WLAN/WiMAX Applications

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Abstract— In this paper, a simple reconfigurable monopole antenna for WLAN/WiMAX application is presented. The proposed antenna has been designed and compared to a three patch strips triple band monopole antenna which operate at 2.45 GHz, 3.5 GHz and 5.8 GHz frequency bands. The antenna has been simulated using CST software studio and fabricated on FR4 substrate. The proposed antenna provides triple bands in which the bandwidth of 367 MHz for 2.45 GHz, 799 MHz for 3.5 GHz and a bandwidth of 3.47 GHz for 5.8 GHz has been obtained. The results show that the measured and simulated return loss characteristic of the optimized antenna satisfies the requirement of the 2.4/5.8 GHz WLAN and 3.5 GHz WiMAX antenna application. The proposed reconfigurable antenna is low profile, compact and small in size and show good performance for WLAN/WiMAX bands. There is good agreement between the measurement and simulation results in terms of return loss and radiation pattern.

1. INTRODUCTION

With the current research trends which require more than one wireless application in one device, has increase the demand on the design of multiband and reconfigurable antennas for wireless application. Reconfigurable antennas usually have the capability in which more than one resonance frequency could be achieved. Using switches different shapes of the radiating element can be created to excite different frequencies.

Most of researches in multiband antenna design for wireless communication focused on planar monopole antenna due to its low cost, good radiation pattern and simple in fabrication [1–3]. There are various techniques which are used to design of multi-band antenna for wireless communication application which includes use of different shapes such as E-shape [4], B-shape monopole [5] and use of slot [6].

However, all these techniques used to design dual or multiband antenna can provides fixed frequency characteristics. Therefore, in this paper, a simple reconfigurable monopole antenna has been investigated and compared with the triple band monopole antenna. The proposed reconfigurable antenna is low profile, compact and small in size compared to the conventional triple band monopole antenna and show good performance for WLAN/WiMAX bands. There is good agreement between the measurement and simulation results in terms of return loss and radiation pattern.

2. ANTENNA DESIGN

The geometry and dimension of the proposed antenna is shown in Figures 1(a)–(b). Figure 1(a) and Figure 1(b) show the geometry of the triple-band antenna and reconfigurable antenna respectively. The antenna comprised of copper strip which contribute to the three resonance frequency of the proposed antenna. The antenna has been designed using CST Microwave studio software. The substrate used is FR4 with permittivity of 4.5, loss tangent of 0.019 and thickness of 1.6 mm. It has been observed that the resonance frequency of the proposed antenna is influenced by the copper strip length of the antenna which is approximately quarter wavelength of the operating frequency. In proposed antenna only strip $A \rightarrow B \rightarrow C$ of the triple band antenna has been used to design reconfigurable antenna which is connected by two switches. In simulation copper strip has been used as switch when it is on state and off state when it is ignored. The optimal design of the proposed antenna has small overall dimension of $20 \times 35 \times 1.6\,\text{mm}^3$ for triple band antenna and $15 \times 33 \times 1.6\,\text{mm}^3$ for the reconfigurable antenna. The prototype of the triple-band antenna is shown in Figure 2.

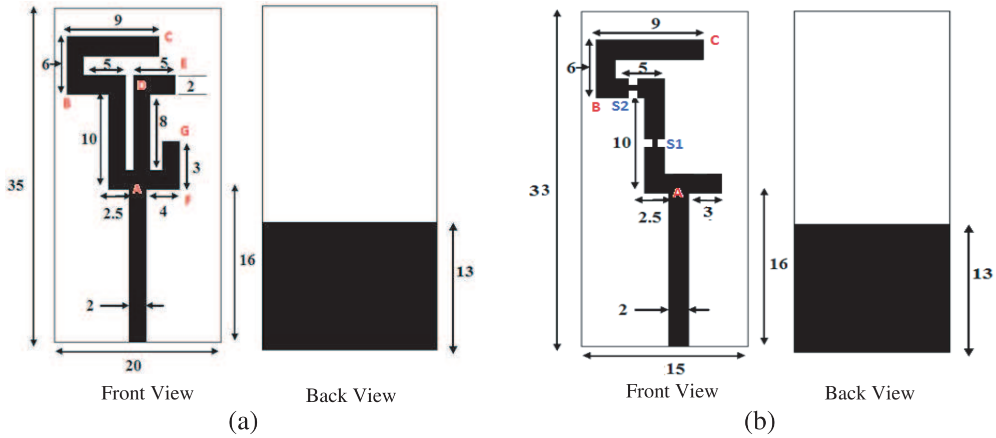
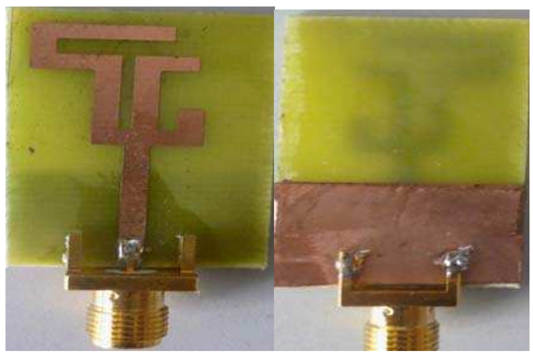


Figure 1: Geometry of (a) triple band monopole antenna and (b) reconfigurable monopole antenna.



(a) (b)

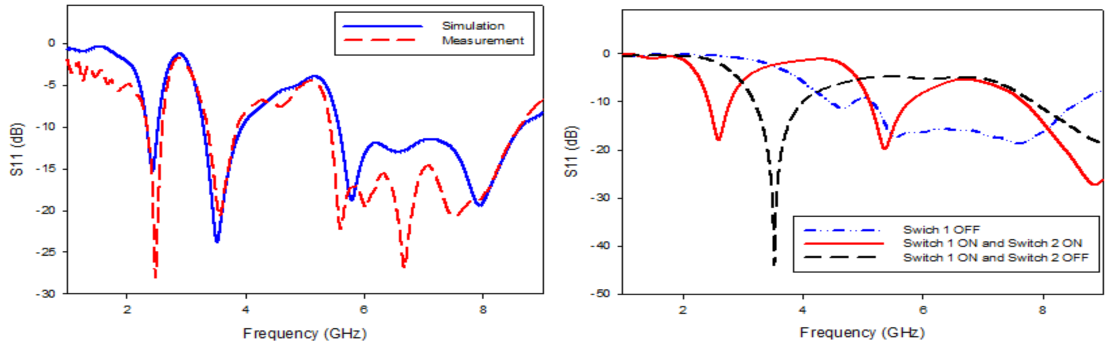
Figure 2: Prototype of triple band monopole antenna. (a) Front view and (b) back view.

3. RESULTS AND DISCUSSION

The reconfigurable monopole antenna has been analyzed and compared to the triple band monopole antenna which provides the same three frequency band. In the triple band antenna analysis, it has been observed that the first resonance frequency is obtained from the patch strip $A \rightarrow B \rightarrow C$ at 2.43 GHz with the return loss value of 15.2 dB. The second resonance frequency is obtained by additional of patch strip at a resonance frequency of 3.52 GHz with the return loss of 23.7 dB and the third resonance frequency is obtained by the strip $A \rightarrow F \rightarrow G$ at 5.8 GHz with the return loss value of 18.65 dB. The proposed reconfigurable monopole antenna is constructed based on the copper strip $A \rightarrow B \rightarrow C$ of the triple band antenna which provides the first resonance frequency. To make it configurable switch 1 and switch 2 has been introduced which make copper strip $A \rightarrow B \rightarrow C$ to be configured to provide additional 3.5 GHz and 5.8 GHz resonance frequencies.

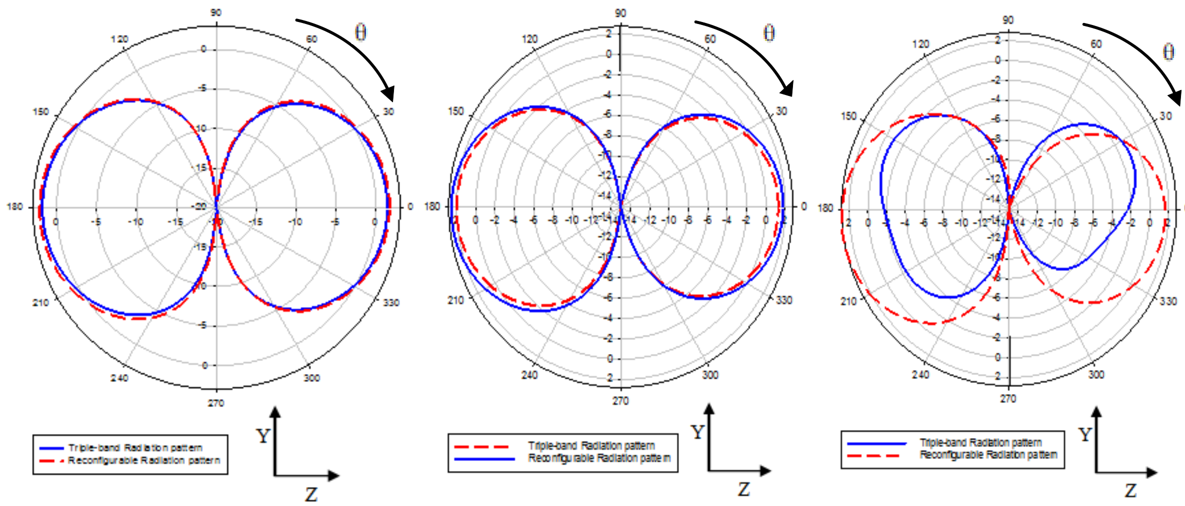
Figure 3(a) shows the comparison between the simulated and measured return loss results of the proposed triple band monopole antenna. It can be seen that the measured and simulated return loss characteristic of the optimized antenna are in good agreement and satisfies the requirement of the 2.4/5.8 GHz WLAN and 2.3/3.5 GHz WiMAX antenna application. Figure 3(b) shows the simulated results of the proposed reconfigurable monopole antenna. The result shows different return loss characteristic of the proposed reconfigurable antenna when first when switch 1 is off or both switch 1 (S1) and switch 2 (S2) are ON and secondly, when switch 1 is ON and switch 2 is OFF. As it can be observed from Figure 3(b) when switch 1 is OFF, the antenna provides -10 dB bandwidth of 367 MHz for 2.45 GHz frequency band and when both switch 1 and switch 2 are ON, the proposed antenna provides -10 dB bandwidth of 799 MHz for 3.5 GHz frequency band and a bandwidth of 3.47 GHz for 5.8 GHz frequency band when switch 1 is OFF and switch 2 is ON.

The simulated radiation pattern of the proposed antenna has been analyzed and compared to the triple band monopole antenna. The E-plane and H-plane radiation pattern of the proposed reconfigurable antenna and triple-band monopole antenna at 2.45 GHz, 3.5 GHz and 5.8 GHz of have been investigated. Figure 4 shows the comparison of the E-plane radiation pattern of the proposed



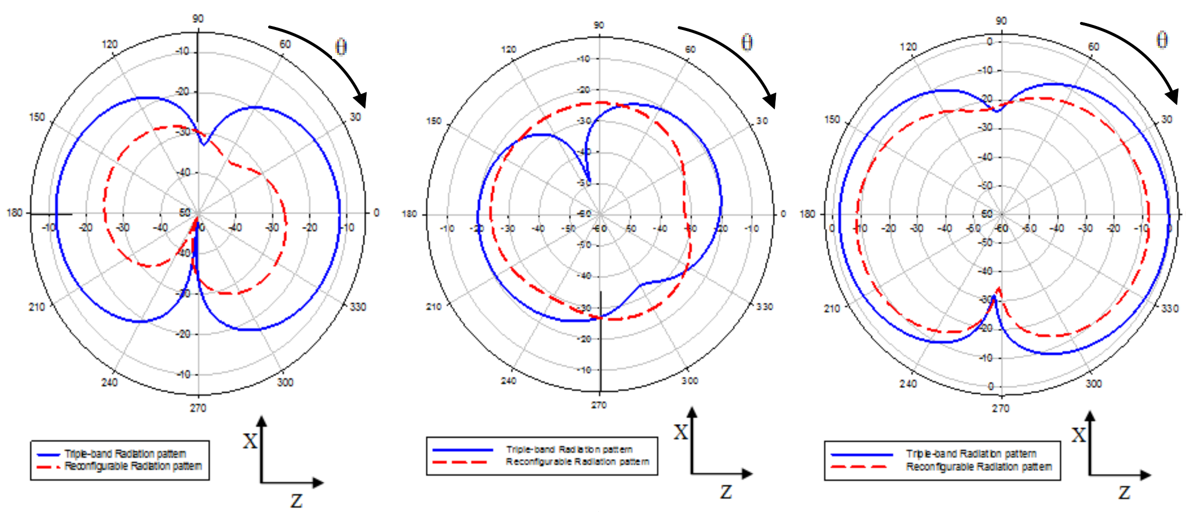
(a) (b)

Figure 3: (a) Measured and simulated return loss of triple band monopole antenna and (b) simulated return loss of reconfigurable antenna for different states of the switches.



(a) (b) (c)

Figure 4: Comparison of simulated E-plane radiation pattern of the triple-band monopole antenna and proposed reconfigurable antenna at (a) 2.45 GHz, (b) 3.5 GHz, (c) 5.8 GHz.



(a) (b) (c)

Figure 5: Comparison of simulated H-plane radiation pattern of the triple-band monopole antenna and proposed reconfigurable antenna at (a) 2.45 GHz, (b) 3.5 GHz, (c) 5.8 GHz.

antenna and triple-band antenna at 2.45 GHz, 3.5 GHz and 5.8 GHz frequency band. It can be seen that the E-plane radiation pattern is bi-directional and similar in shape with exceptional of radiation pattern at 5.8 GHz which have some deviation between the two antenna. Figure 5 shows H-plane radiation pattern at 2.45 GHz, 3.5 GHz and 5.8 GHz frequency bands. It can be seen that H-plane radiation pattern are close to omnidirectional and have similar shape between the two antennas.

4. CONCLUSION

In this paper a simple reconfigurable monopole antenna for WLAN/WiMAX application has been presented and compared with triple band monopole antenna in term return loss and radiation pattern performance. The proposed antenna provides the -10 dB bandwidth of 367 MHz for 2.45 GHz, 799 MHz for 3.5 GHz and a bandwidth of 3.47 GHz for 5.8 GHz which is better compared to that triple band monopole antenna which provides bandwidth of 200 MHz, 640 MHz, and 3.04 GHz for 2.45 GHz, 3.5 GHz and 5.8 GHz respectively. The reconfigurable monopole antenna has reduced size compared to the triple-band monopole antenna; however, the performance of the reconfigurable monopole antenna provides better result in term of return loss and radiation pattern.

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