IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 8, August 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

A Novel Compact Size Reconfigurable Antenna with Ability to Select Of WLAN/WIMAX Application Frequency

Salar jafari[1] and Yashar Zehforoosh[1*]

[1]Department of Electrical Engineering, Urmia Branch, Islamic Azad University, Urmia, Iran

Abstract
A miniaturized reconfigurable microstrip fed antenna with ability to change single and double band function for WLAN/WiMAX applications is presented in this study. In the proposed structure, by cutting two slots on the radiating patch and embedding two U- and L-shapes arms and positive-intrinsic-negative (PIN) diodes along these arms, switchable single band notch performances are added to the antenna performance. Good agreement between the simulated and the measured results is achieved at different performances of the antenna. The designed antenna has a small size of 17×16 mm^2 and the measured results reveal that the fabricated antenna has good radiation behavior in the WLAN/WiMAX frequency spectrum with switchable band notch functions at 3.8–4.2 GHz, which can eliminate the broadband frequency band interference with the WiMAX, the C-band and the WLAN systems

Keywords: monopole antenna, reconfigurable, WiMAX, WLAN

1. Introduction

Printed monopole antennas have attracted much research interest because of their advantages of low cost, easy fabrication and moderate performance. Today's communication systems demand both increased performance and reduced size. A frequency-reconfigurable antenna provides the capability for the antenna to operate in only the desired frequency range while rejecting neighboring ones. This reduces interference that will consequently increase signal-to-noise ratio, thus channel capacity or power efficiency. An antenna that covers multiple bands provides an aperture that can be used for multiple applications, thus a reusable aperture, or the entire bandwidth can be used simultaneously to provide high data rate. Also by consolidating the number of antennas required, the overall size of the system is decreased. If the antenna dimension is small such that it can be used as a scanning array element (typically at the highest frequency of operation), high gain and/or beam-scanning applications can be accommodated [1-9]. A reusable aperture, high data rate capability, and beam-scanning capability create a multipurpose system, which decreases the number of antennas required to cover various applications while increasing system capability. Typically, when frequency-reconfigurable antennas are designed, the main focus is on changing the input impedance, which determines the overall matching response [2]. For an antenna to be capable of covering several wideband applications (frequency bands), contiguous matching frequency bands and a comprehensive wideband frequency band (covering all of the smaller contiguous matching bands) are desired. In [3], p-i-n diodes are located in a microstrip feedline, which is electromagnetically coupled to a slot antenna, to vary the feedline length, which varies the operating frequency. Two contiguous wideband frequency bands (64% and 55%) are achieved, but this design lacks the comprehensive wideband frequency band, and the radiating slot is large (1.1λ at the highest frequency). In [4], a planar monopole antenna (PMA) is combined with a reconfigurable coplanar waveguide (CPW) filter, and varactor diodes are used to reconfigure the filter. Five contiguous narrowband frequency bands with 39% total reconfigurable bandwidth are achieved in addition to a wideband frequency band with 58% bandwidth, but the width of the PMA with biasing lines is at the 1.1λ highest frequency. Both of these antenna elements will be too large to use as the radiating element in an array. In this letters a compact reconfigurable frequency switching antenna is presented. This antenna can be change single and double band application in WLAN/WiMAX performance.

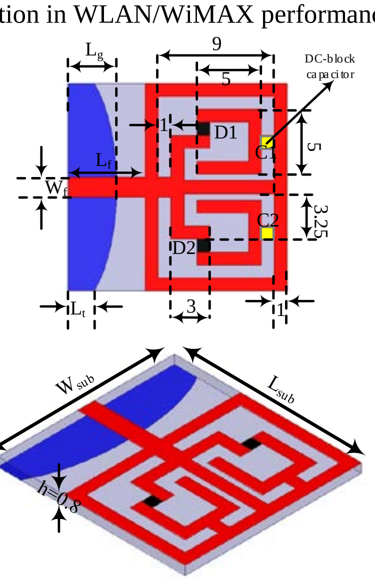


Fig. 1 configuration of reconfigurable proposed antenna (L_g=3.8, L_f=6, L_t=2.04, and W_f=1.5) (all value in mm.)

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 8, August 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

1.2 Antenna configurations

In Fig.1, configuration of proposed antenna is indicated. The antenna size is 17×16 mm^2, which printed on 0.8mm thickness FR4 substrate with relative permittivity of εr=4.4 and loss tang of 0.02. To achieve 50Ω input impedance is employed of microstrip feed line with width of W_f. By helping from a semi-elliptical shape ground, structure bandwidth of antenna is improved. In order to frequency control and also, to avoid DC short circuit in the P-I-N diodes biasing circuits, two 100 pF DC blocking capacitors is utilized. In fact, in this antenna by switching PIN diode effective size of antenna changes which causes to control of frequency band.

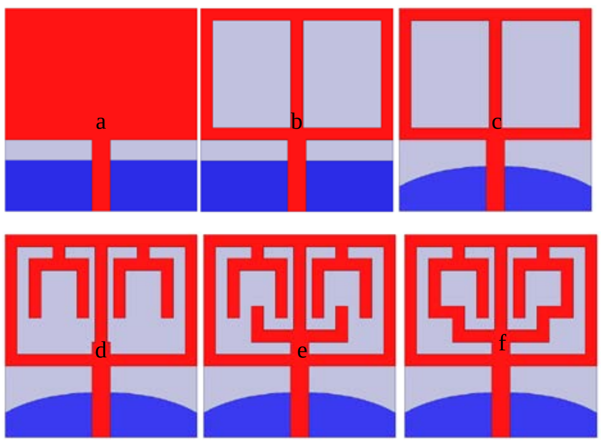
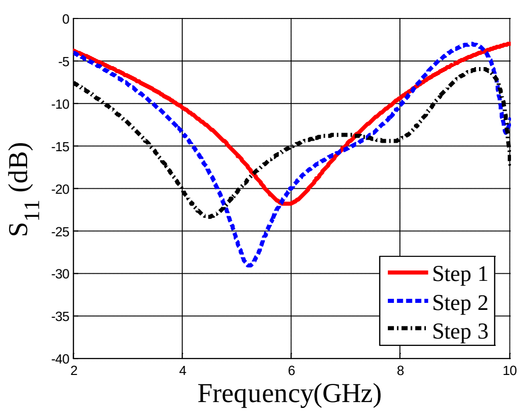
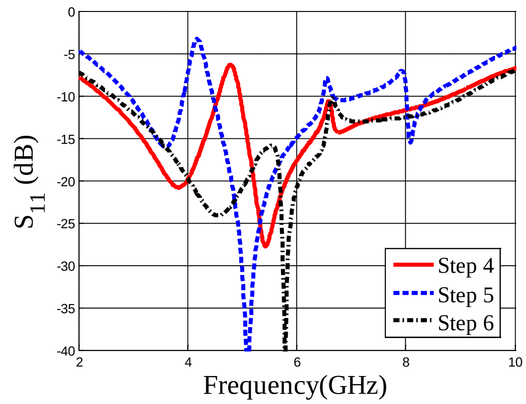


Fig. 2 six steps of proposed antenna design



a

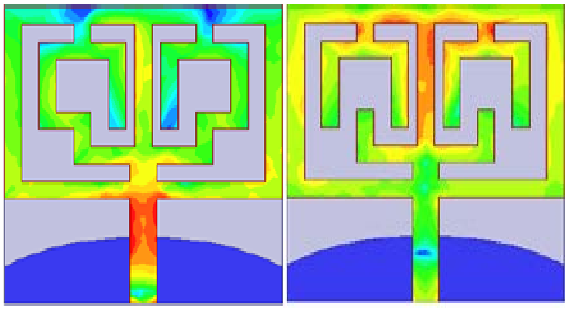


b

Fig. 3 simulation results of S11 for six steps pf designing in Fig. 2

1.3 Results and discussion

A prototype of the proposed microstrip reconfigurable antenna with its final modified parameters, based on the aforementioned design approach is designed, fabricated and tested and in this section the numerical and the experimental results of its S_{11} and the radiation characteristics are presented and discussed. The simulated results are obtained by using Ansoft Simulation Software High Frequency Structure Simulator (HFSS) [10]. Various antenna structures which were compared with the proposed structure in the simulation studies are shown in Fig. 2 and their S_{11} characteristics is compared in Fig. 3. The frequency responses of the ordinary square microstrip patch antenna (Fig. 2a), the antenna with the cut of patch (Fig. 2b) and the proposed reconfigurable slot antenna at its broadband performance (Fig. 2c) are compared in Fig. 3. As depicted in figure 3, the ordinary square microstrip antenna has a resonance within the broadband spectrum and then by cutting the modified patch on the feed-line and change rectangular ground to elliptical shape the antenna is capable to excite an additional resonance (second resonance) at 8 GHz which leads to improved coverage of the WLAN/WiMAX bandwidth (2.7–8.7GHz). By embedding two U shape, as seen in Fig. 2d, because an arm with quarter wavelength is added to patch, range of upper frequency is optimized. But with Accumulation, flow current of patch in to arms, the arms are operated like notch and causes to band notch from 4.8 to 5.6GHz. Therefore, for return flow current in U-shape arms to radiated elements is used two L-shape arms. Finally, in order to control BW of antenna is employ two PIN diode which capable to remove or creating frequency range between from 4.8 to 5.6GHz.



a b

Fig. 4 current distribution of antenna at 5.5GHz for two state a) both diodes are ON b) both diodes are OFF

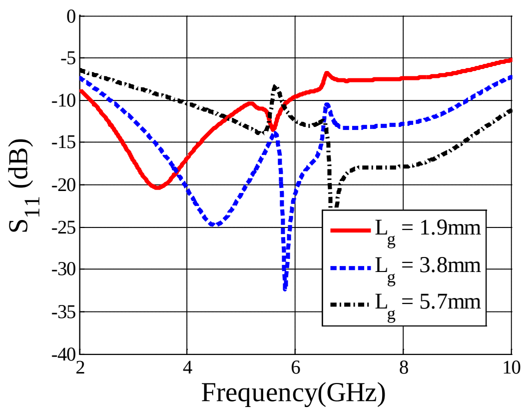
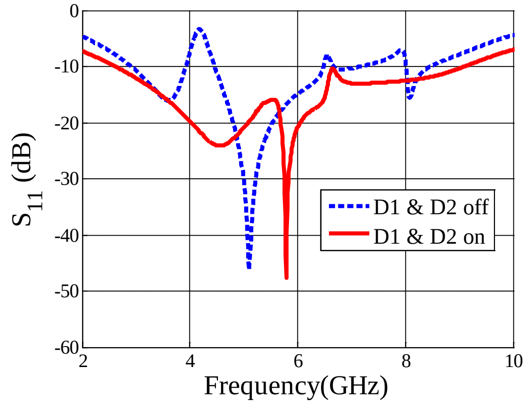
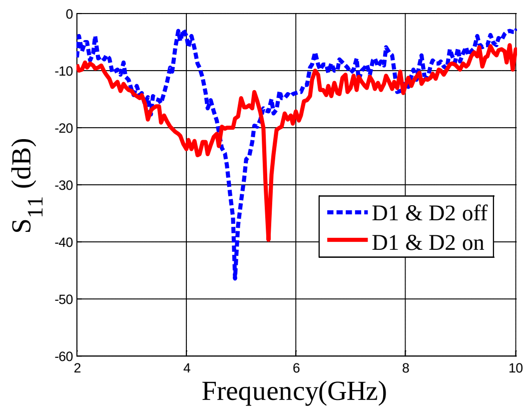


Fig. 5 the effect of the variation in the dimensions of the elliptical ground

To give a clearer and illustrated insight about the phenomenon behind the various switchable functions of the presented reconfigurable antenna the surface current distribution on the feed-line and the radiating stub at particular frequencies is presented in Fig. 4. To obtain the modified and the final values for the different design parameters of the proposed antenna, a parametric study was performed in which a parameter was changed at a time, whereas the others were kept fixed. The final modified values of the design parameters are listed in caption of Fig. 1, and also Fig. 5 shows an example of this parametric study. In Fig. 5, the effect of the variation in the dimensions of the elliptical Ground on the radiating which creates the lower band function is shown. As can be seen in this figure, by changing the dimensions of the corresponding ground, the attenuation can be properly adjusted towards the preferred frequency band. The proposed microstrip antenna with its final design parameters is fabricated and tested.



a



b

Fig. 6 comparison between simulated and measured results a) Simulated and b) Measured

Fig. 6 shows the realized antenna and its measured return loss characteristics for different on and off statuses of the PIN diodes are presented in Fig. 6. The measured results reveal that the fabricated antenna can satisfy the requirements for WLAN/WiMAX performance in the frequency band of 2.5–10.6 GHz with the dual band function at 3.1–3.85 and 5.43–6.1 GHz. Also, it is found out that by changing the biasing statuses of the PIN diodes, the fabricated antenna is capable of exhibiting two separate single band notch performances at the frequency bands of 2.3–5.2 and 5.2–5.9 GHz, respectively, as illustrated in Fig. 6. Moreover, there is a discrepancy between the measured results and the simulation data which can be because of a number of reasons such as the accuracy of the substrate on which the antenna is fabricated or the effect of the biasing circuits of the PIN diodes, but totally, they are in good agreement. The measured radiation pattern of the fabricated antenna including the co-polarization and cross-polarization in the H-plane (X−Z plane) and E-plane (Y−Z plane), respectively, for its dual band notch performance at three various frequencies is depicted in Fig. 7. As observed in this figure, the antenna has suitable radiation in a wide

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 8, August 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

range of frequencies and also the radiation patterns in the X−Z plane are almost Omni-directional. The comparison between proposed antenna and same work, which published in recent years, is exhibition in Table 2. It shows the proposed antenna with compact size and broadband BW than mentioned work can be performed in WLAN/WiMAX application. The photograph of fabricated antenna is illustrated in Fig.8.

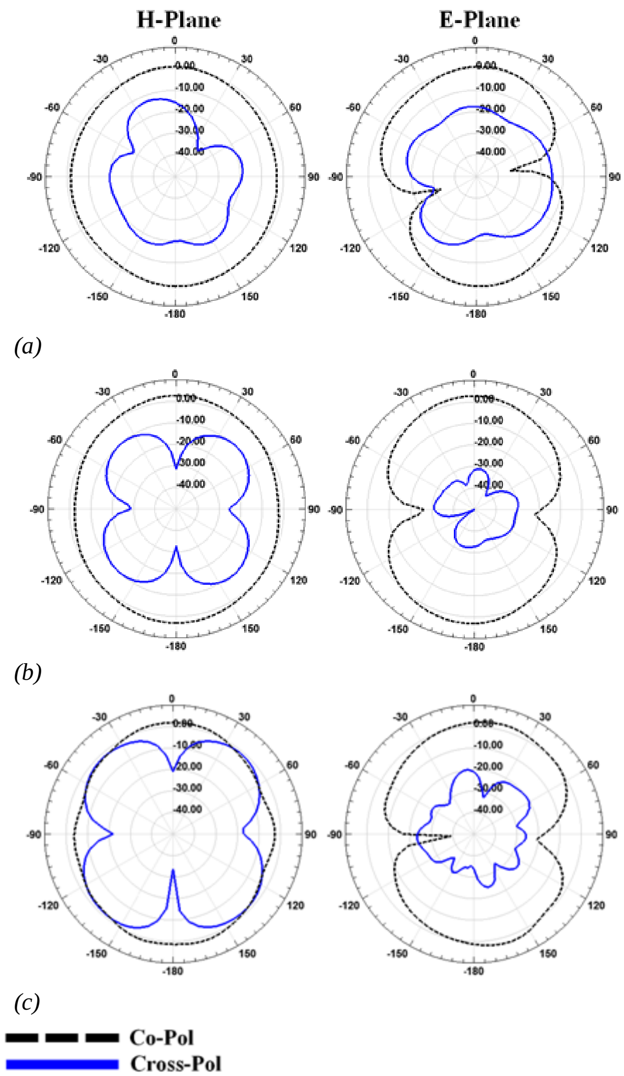


Fig. 7 measured radiation pattern at a)3.5 GHz both diodes are OFF b) 5.5 GHz both diodes are OFF c)6 GHz both diodes are ON

Fig. 8 photograph of fabricated antenna

Table 1. Comparison between proposed antenna and same *work*

characteristics	Pin diode[11]	Pin diode
B.W.	2.4-2.6 GHz	2.5-8.6 GHz
number of PIN diode	3	2
switchable states	3	2
feeding methode	Microstrip	Microstrip
Size	50×50	17×16
Substrate	Rogers	FR4

Conclusion

In this paper, a novel compact reconfigurable printed antenna with switchable single band notch performances has been proposed for the WLAN/WiMAX applications. In the proposed antenna, wider and improved impedance bandwidth especially at the higher frequency band is obtained by cutting two modified square patch. Switchable single band notch function is obtained by embedding two modified L- and U-shapes on the patch and embedding two PIN diodes along the slots. By changing the bias statuses of the PIN diodes, the antenna is able to switch between its various frequencies responses. The fabricated antenna satisfies the VSWR<2 requirement for 2.5–8.6 GHz with a band rejection performance in the frequency band of 3.8–4.2 GHz and the proposed antenna has a simple configuration and is easy to fabricate.

Reference

[1] Badamchi, Z. and Zehforoosh, Y. (2015), Switchable single/dual band filtering UWB antenna using parasitic element and T-shaped stub wave cancellers. Microw. Opt. Technol. Lett., 57: 2946–2950.

[2] Sefidi, M., Zehforoosh, Y. and Moradi, S. (2015), A novel CPW-fed antenna with dual band-notched charectrestics for UWB applications. Microw. Opt. Technol. Lett., 57: 2391–2394.

[3] Siahcheshm, A., Nourinia, J., Zehforoosh, Y. and Mohammadi, B. (2015), A compact modified triangular CPW-

fed antenna with multioctave bandwidth. Microw. Opt. Technol. Lett., 57: 69–72.

[4] Tariq and H. Ghafouri-Shiraz, “Frequency-reconfigurable monopole antennas,” IEEE Trans. Antennas Propag., vol. 60, no. 1, pp. 44–50, Jan. 2012.

[5] R. Simons, D. Chun, and L. P. B. Katehi, “Reconfigurable array antenna using microelectromechanical systems (MEMS) actuators,” in Proc. IEEE Antennas Propag. Soc. Int. Symp., Boston, MA, Jul. 2001, vol. 3, pp. 674–677.

[6] L. Feldner, C. D. Nordquist, and C. G. Christodoulou, “RF MEMS reconfigurable triangular patch antenna,” in Proc. IEEE Antennas Propag. Soc. Int. Symp., Washington, DC, Jul. 2005, vol. 2A, pp. 388–391.

[7] J. T. Rayno and S. K. Sharma, “Compact spirograph planar monopole antenna covering C-/X-band with invariant radiation pattern characteristics,” IEEE Trans. Antennas Propag., vol. 60, no. 12, pp. 6002–6007, Dec. 2012.

[8] J. T. Rayno and S. K. Sharma, “Beam steering performance of a Cand X-band compact spirograph PMA (SPMA) array,” in Proc. IEEE Antennas Propag. Soc. Int. Symp., Chicago, IL, Jul. 2012, pp. 1–4.

[9] J. T. Rayno and S. K. Sharma, “Frequency reconfigurable spirograph planar monopole antenna (SPMA),” presented at the Int. Symp. Antennas Propag., Nagoya, Japan, Nov. 2012.

[10] Ansoft High Frequency Structure Simulator (HFSS), Ver. 13, Ansoft Corporation, 2010

[11] Muhammad Usman Memon and Sungjoon Lim," *Frequency-Tunable Compact Antenna using Quarter-Mode Substrate Integrated Waveguide* ",10.1109/LAWP.2015.2413945, IEEE Antennas and Wireless Propagation Letters