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Frequency Reconfigurable Microstrip Antenna for Wireless Applications

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ABSTRACT
A new frequency reconfigurable microstrip antenna is presented for wireless applications. Initially individual patch antennas are designed for GSM, Wi-Fi, Wi-MAX. Later, these antennas are combined and diodes are introduced to generate the frequency reconfigurability. Based on the ON/OFF condition of the diodes, frequency agility is achieved at 1.8 GHz, 2.4 GHz, and 3.4 GHz bands.

Keywords – Frequency reconfigurable, GSM, Microstrip antenna, Wi-Fi, Wi-MAX.

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I. INTRODUCTION

There is a tremendous growth in the field of wireless communications. Reconfigurable antennas have attracted the many antenna designers because of the capability of dynamically change of their characteristics. Based on the type of parameters, antennas are known as frequency, radiation, polarization reconfigurable antennas. Nowadays all the wireless devices supports various applications at several frequency bands. During traditional days separate antennas are used for various bands. So, these antennas occupy lot of space. If a single frequency reconfigurable antenna is used for all these applications, space on the board can be saved and cost of the system can be reduced.

In 1981 D. H. Schaubert came up with a novel technique to control the operating frequency and polarization of the microstrip antennas [42]. The control is accomplished by putting shorting posts at proper locations inside the patch boundaries. Frequency tuning can be done by changing the location and number of the posts. With the use of shorting posts frequency change is obtained without altering the input impedance and without increasing the complexity of the feed network. Here microwave switching diodes are used as shorting posts to achieve the frequency reconfigurable radiation. These shorting posts between the patch and ground plane also reduce the size of the microstrip antenna [43]. By using four metallic posts at appropriate locations and an L-probe feed, a circular patch antenna is demonstrated for wideband frequency agility [44]. The antenna is operated at 1.85 GHz frequency with VSWR < 2 bandwidth of 24%. A novel defected ground structure resonator antenna with coplanar waveguide (CPW) feeding technique is proposed by Heba B. El-Shaarawy et al for reconfigurable frequency operation [45]. Here, two separate square resonator slots with a small thickness are etched on the ground plane. Further PIN diodes are used to form closed and open loop for both the slots. By switching ON/OFF these three diodes, frequency agility is achieved. H. A. Majid has presented a novel frequency reconfigurable design with a slot in the ground plane [46]. Reconfiguration is achieved by positioning five PIN diodes as switches on the slot. By toggling the switches, frequency switching is obtained at six frequency bands between 2.2 and 4.75 GHz. Abdel-Fattah Sheta et al have designed a slotted rectangular patch antenna with shorting posts at patch edge for frequency reconfigurable operation [47]. PIN diode switches are used as short circuit posts to the ground plane. Several sub bands are obtained between the 620 to 1150 MHz frequencies with this antenna. A microstrip line fed E-shaped patch and slotted ground plane with PIN diodes is suggested by Huda A. Majid et al for frequency reconfiguration between the 1.98 and 3.59 GHz frequencies [48]. A frequency tunable antenna with loaded short circuited posts between the ground plane and slotted rectangular patch is discussed by Yufeng Yu et al in [49], while the posts are placed at the patch edges. An L-shaped slot structure with PIN diodes, lumped capacitors and bias network is modeled for reconfigurable frequency by M. I. Lai et al [50]. Several antennas are proposed for frequency agility in open literature

[10] – [12]. In this paper a frequency agile antenna using square patches and diodes are proposed.

II. ANTENNA CONFIGURATION

At first, three different square patch antennas are designed for GSM, Wi-Fi and Wi-MAX bands. The specifications of simulated antennas are: the thickness (h) of the substrate is 3.2 mm, relative permittivity (ε_r) is 2.2, loss tangent is 0.0019. The cross sectional view of the antenna is pictured in Fig. 1. To resonate the antenna at GSM band the square patch side length is considered as 24 mm, whereas for Wi-Fi, Wi-MAX antennas dimensions are 34mm and 48 mm. The diodes (D_1, D_2, D_3, D_4, D_5, D_6, D_7, D_8) are introduced along the x and y axes. A simple probe feed is used here for feeding purpose. The top view of the presented structure is portrayed in Fig. 2.

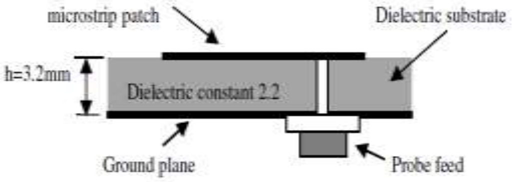


Figure 1. The proposed antenna cross sectional view.

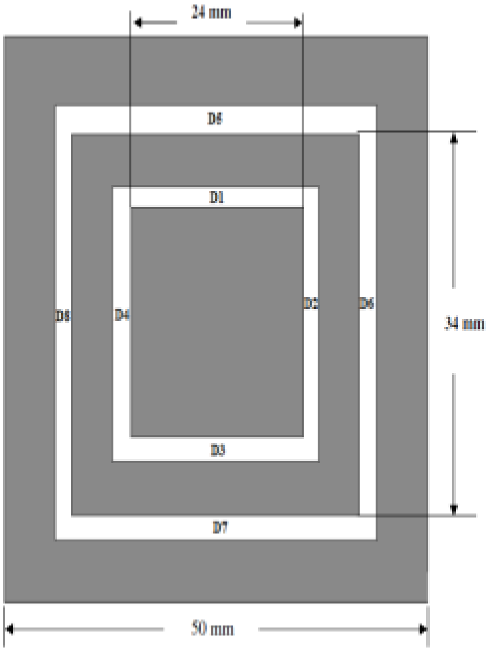


Figure 2. The presented antenna top view.

III. RESULTS AND DISCUSSIONS

To simulate the proposed antenna, finite element method based HFSS EM simulator is used. Antenna structure resonating at Wi-MAX band is shown in Fig. 3. When all the diodes are OFF, the smaller patch with 24 mm side length resonates at 3.5 GHz. From the Fig. 4, it is observed that strong current distributed along the sides of the smaller patch. The simulated reflection coefficient is given in the Fig. 5.

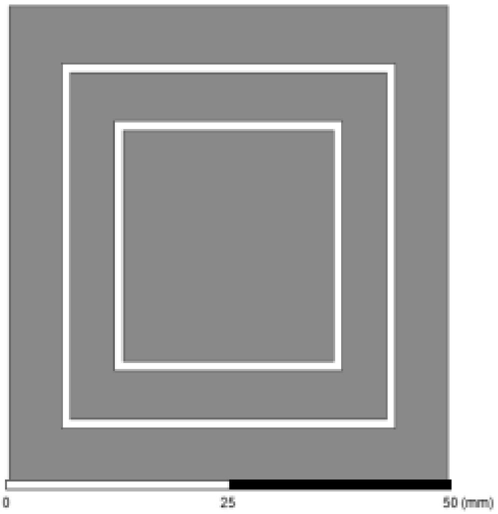


Figure 3. The Wi-MAX band structure.

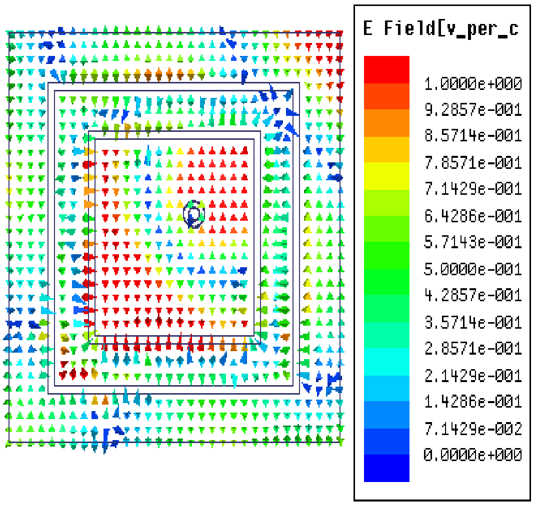


Figure 4. Current distribution on Wi-Max patch.

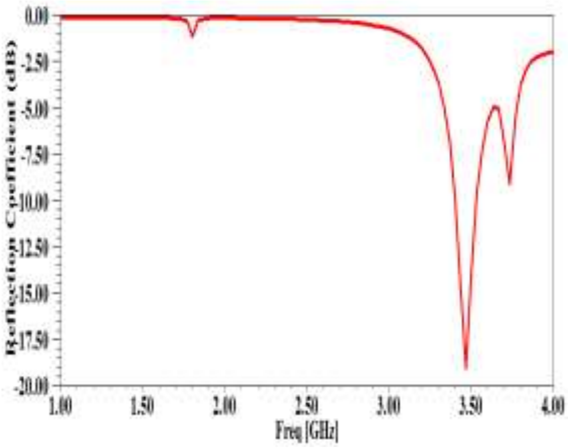


Figure 5. Reflection coefficient of Wi-MAX patch.

For reconfiguration of frequency band, four diodes (D_1, D_2, D_3, D_4) are switched ON. When these diodes are ON 24 mm side length, 34 mm side length patches are connected and the antenna shifts the resonating band to Wi-Fi. The proposed antenna, current distribution, and reflection coefficient are given in Fig. 6, 7, and 8 respectively. It is dentified strong current distribution along the 34 mm side length patch.

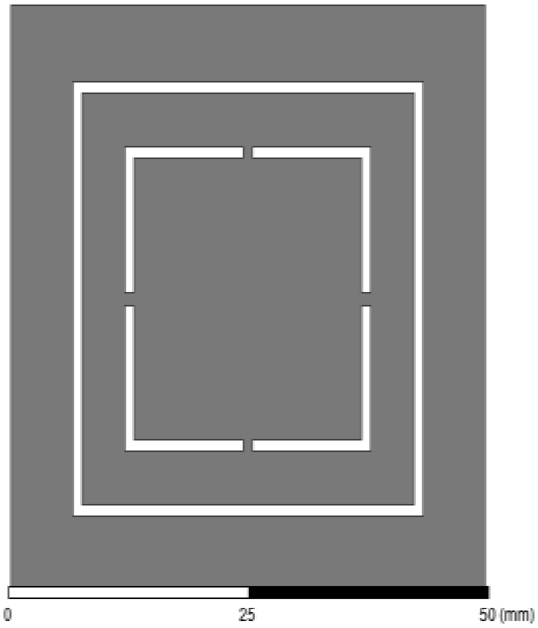


Figure 6. The Wi-Fi band structure.

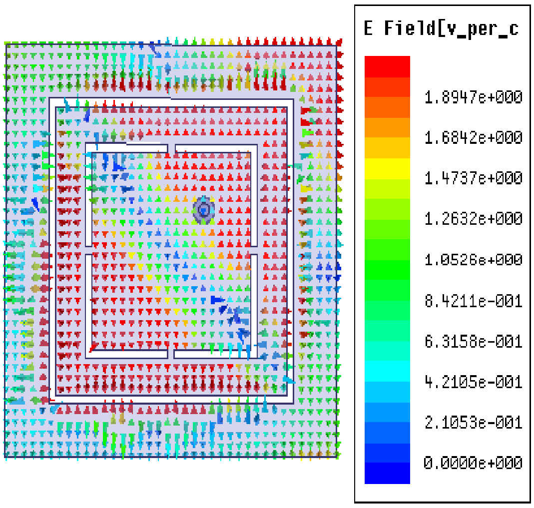


Figure 7. Current distribution on Wi-Fi patch.

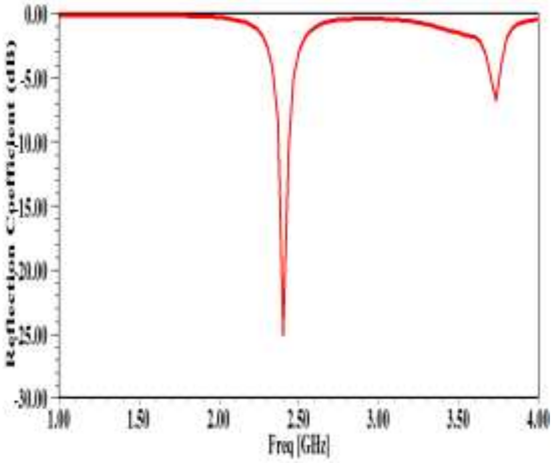


Figure 8. Reflection coefficient of Wi-Fi patch.

When all the diodes are ON, all three patches are connected each other and becomes a single patch of dimension 50mm. Now the antenna resonates at GSM 1.8 GHz frequency. The corresponding GSM band antenna structure, current distribution, and reflection coefficients are given in Fig. 9, 10 and 11.

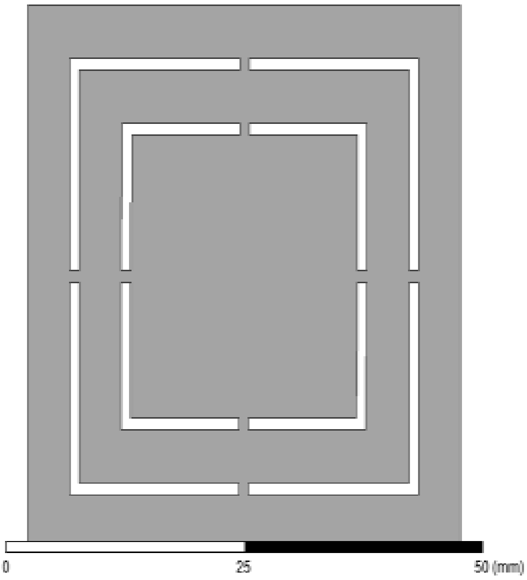


Figure 9. The GSM band structure.

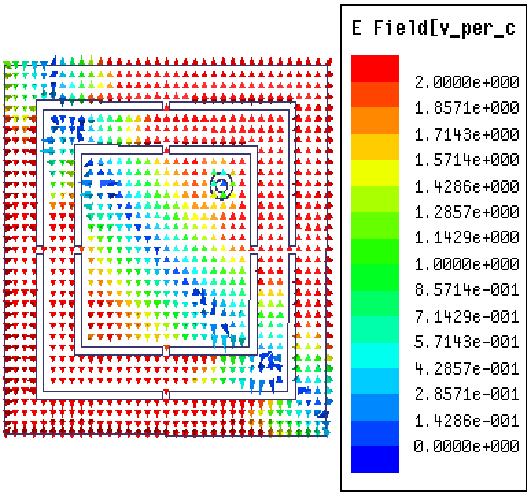


Figure 10. Current distribution on GSM patch.

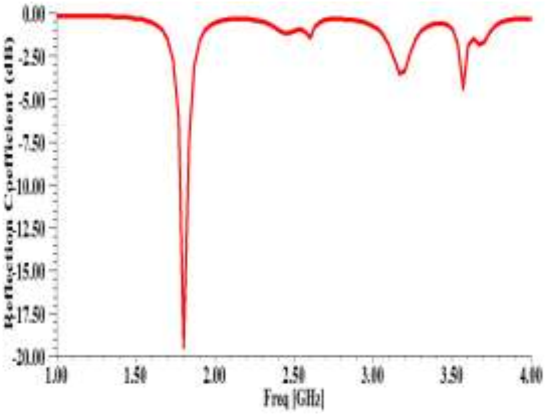
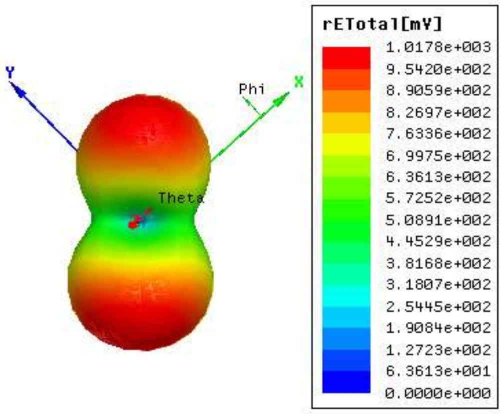
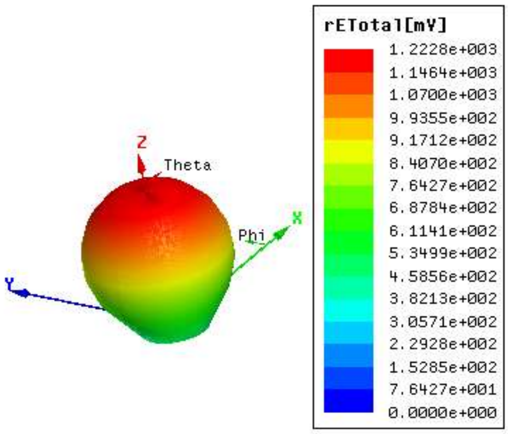


Figure 11. Reflection coefficient of GSM patch.

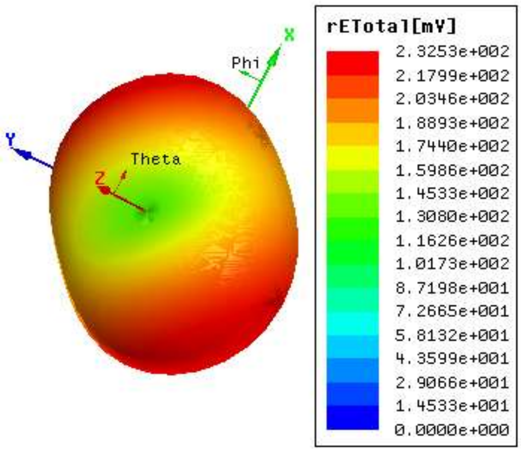
The 3D polar plot of the proposed antenna at the three resonating frequencies 1.8 GHz, 2.4 GHz, and 3.4 GHz is shown in Fig. 12. The bandwidth obtained at resonatng GSM, Wi-Fi, and Wi-MAX bands are 49.4 MHz, 65.2 MHz, and 130 MHz respectively.



(a) at 1.8 GHz



(b) at 2.4 GHz



(c) at 3.45 GHz

Figure 12. The 3D polar radiation patterns.

IV. CONCLUSION

In this paper square patch antenna is designed for frequency reconfigurable operation. The bandwidth generated at the three resonating 1.8 GHz, 2.4 GHz, and 3.45 GHz frequencies is 2.7 %, 2.6 % and 3.7 % respectively. The proposed antenna is also giving a gain of more than 3 dBi at the bands. So, the proposed antenna is a good choice for all the handheld devices which supports GSM, Wi-Fi, and Wi-MAX applications.

REFERENCES

[1]. Daniel. H. Schaubert, Frederick G. Farrar, Arthur Sindoris, and S. Hedayati, Microstrip antennas with frequency agility and polarization diversity, IEEE Trans. Antennas and Propagation, 29 (1), 1981, 118–123.

[2]. Aaron K. Shackelford, Kai-Fong Lee, and K. M. Luk, Design of Small-Size Wide-Bandwidth Microstrip-Patch Antennas, IEEE Antennas and Propag. Magazine, 45(1), 2003, 75–83.

[3]. Shing-Lung Steven Yang, and Kwai-Man Luk, Design of a Wide-Band L-Probe Patch Antenna for Pattern Reconfiguration or Diversity Applications, IEEE Trans. Antennas and Propagation, 54 (2), 2006, 433–438.

[4]. Heba B. El-Shaarawy, Fabio Coccetti, Robert Plana,Mostafa El-Said, and Essam A. Hashish, Novel Reconfigurable Defected Ground Structure Resonator on Coplanar Waveguide, IEEE Trans. Antennas and Propagation, 58 (11), 2010, 3622–3628.

[5]. Huda A. Majid, M. Kamal A. Rahim, M. Rijal Hamid, and M. F. Ismail, A Compact Frequency-Reconfigurable Narrowband Microstrip Slot Antenna, IEEE Antennas and Wireless Propagation Letters, 11, 2012, 616-619.

[6]. Abdel-Fattah Sheta and Samir F. Mahmoud, “A Widely Tunable Compact Patch Antenna,” IEEE Antennas and Wireless Propagation Letters, 7, 2008, pp. 40-42.

[7]. Huda A. Majid, Mohamad Kamal Abdul Rahim, Mohamad Rijal Hamid, Noor Asniza Murad, and Mohd Faizal Ismail, Frequency-Reconfigurable Microstrip Patch-Slot Antenna, IEEE Antennas and Wireless Propagation Letters, 12, 2013, 218-220.

[8]. Yufeng Yu, Jiang Xiong, Hui Li, and Sailing He, An Electrically Small Frequency Reconfigurable Antenna With a Wide Tuning Range, IEEE Antennas and Wireless Propagation Letters, 10, 2011, 103-106.

[9]. M. I. Lai, T. Y. Wu, J. C. Hsieh, C. H. Wang, S. K. Jeng, Design of reconfigurable antennas based on an L-shaped slot and PIN diodes for compact wireless devices, IET Microwaves Antennas and Propagation, 3 (1), 2009, 47–54.

[10]. Saud M. Saeed, Constantine A. Balanis, IEEE, and Craig R. Birtcher, Inkjet-Printed Flexible Reconfigurable Antenna for Conformal WLAN/WiMAX Wireless Devices, IEEE Antennas and Wireless Propagation Letters, 15, 2016, 1979–1982..

[11]. I.A. Yasir, G.A. Oguntala, A.S. Abdullah, Husham J. Mohammed, Ramzy A. Ali, Raed A. Abd-Alhameed, and James M. Noras, Design of frequency reconfigurable multiband compact antenna using two PIN diodes for WLAN/WiMAX applications, IET Microwaves Antennas and Propagation, 11, 2017, 1098 –1105.

[12]. Jingya Deng, Simin Hou, Luyu Zhao, and Lixin Guo, A Reconfigurable Filtering Antenna With Integrated Bandpass Filters for UWB/WLAN Applications, IEEE Trans. Antennas and Propagation, 66 (1), 2018, 401–404.

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