V

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN: 2456-172X | Vol. 4, No. 3, SEP-NOV 2021
Pages 157- 162| Cosmos Impact Factor (Germany): 5.195
Received: 02.09.2019 Published: 28.11.2019

REDESIGN THE FREQUENCY BANDS USED FOR WIRELESS COMMUNICATION APPLICATIONS

Dr. K MURALI BABU[1], RANI MATHEW[2], JINU MATHEW[3], BASIL KURIAKOSE[4]
Professor[1], Assistant Professor[2,3,4]
Department of Electronics and Communication Engineering,
Indira Gandhi Institute of Engineering and Technology Nellikuzhi P.O, Kothamangalam,
Ernakulam (Dist) Pincode 686691

Abstract

This research article presents a new circular slotted multiband antenna designed for wireless applications. The antenna may be easily designed by creating a Defected Ground Structure (DGS) using circular slots of varying radii. The antenna consists of a 50 ohm feeding line as a radiator and a rectangular-shaped slit linked to circular slots on the ground plane. Furthermore, the production of reconfigurable multiband resonances is facilitated by strategically positioning PIN diodes in the circular slots of the defective ground plane and toggling their state (ON/OFF) as needed. The antenna demonstrates three adjustable resonant frequency bands, namely 2.5/3.5/5.7 GHz, which are used in WLAN/WiMax/UWB applications. The antenna is constructed using a FR4 substrate. The object has a small size, measuring 28 × 16 × 0.8 mm3. The design and simulation work in this research is conducted using HFSS. The ability to adjust the resonant frequency bands over a broad range indicates that the suggested antenna design is suitable for many wireless communication applications.

Keywords: redesign, multiband, wireless communication, PIN diodes, and DGS.

1. Introduction

The Microstrip patch antenna (MPA) has gained significant recognition in the realm of wireless communication systems, including WLAN and WiMAX [1-2]. Typically, the multiband microstrip patch antenna is primarily designed to support various wireless protocols such as WLAN and WiMAX, specifically referring to the IEEE 802.11 and 802.16 standards [3-5]. Consequently, the researchers prioritise the integration of several communication technologies into a unified package. The UWB antenna is a potential option, but its wide bandwidth of 7.5 GHz poses a significant difficulty in terms of interference with nearby communication equipment. An alternative approach to address this issue is to develop a versatile multiband antenna that can be adjusted and adapted. Several multiband designs in the current literature have been shown to resonate at certain frequency bands [3-5]. This study presents a proposal for a miniaturised reconfigurable multiband antenna. The proposed antenna demonstrates adjustable resonant frequencies with excellent matching ($S11 \leq -10$dB) at 2.5/3.5/5.7GHz. A defective ground structure (DGS) is formed on the back side of the substrate by circular holes of varying radii. PIN diodes function as switches inside circular slots on a ground plane in order to create various resonant frequency ranges. The suggested antenna offers adjustable band-pass properties at certain frequencies: 2.5 GHz for WLAN, 3.5 GHz for WiMAX, 5.7 GHz for WLAN, and 6.5 GHz for C-band.

V

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN: 2456-172X | Vol. 4, No. 3, SEP-NOV 2021
Pages 157- 162| Cosmos Impact Factor (Germany): 5.195
Received: 02.09.2019 Published: 28.11.2019

2. Antenna Design and Configuration

2.1 Design of Antenna Element

Figure 1 illustrates the geometric configuration of the antenna design being suggested. The antenna design is simulated using a low-cost FR4 substrate with a relative permittivity (εr) of 4.4 and a thickness of 0.8 mm. The suggested antenna has a small overall dimension of 28 * 16 mm2. The top layer of the laminate consists of the antenna feed line. The ground plane is positioned on the posterior surface of the substrate. The proposed radiating patch is a microstrip antenna with a 50 ohm feed and dimensions of 18.4 x 1.6 mm2. The rectangular shape is designed to optimise the impedance match over a broad frequency range. The proposed design of an antenna element demonstrates excellent impedance matching throughout a frequency range of 2 GHz to 7 GHz. Table 1 displays the design parameters for antenna design.

Table 1 Optimized Values of Proposed Antenna

Optimized values of proposed antenna					
Parameter	L	P_W	G_L	W	P_L
Value (mm)	28	1.6	3	16	18.4
Parameter	R_1	R_2	R_3	G_w	-
Value (mm)	2	3.1	2.7	4.8	-

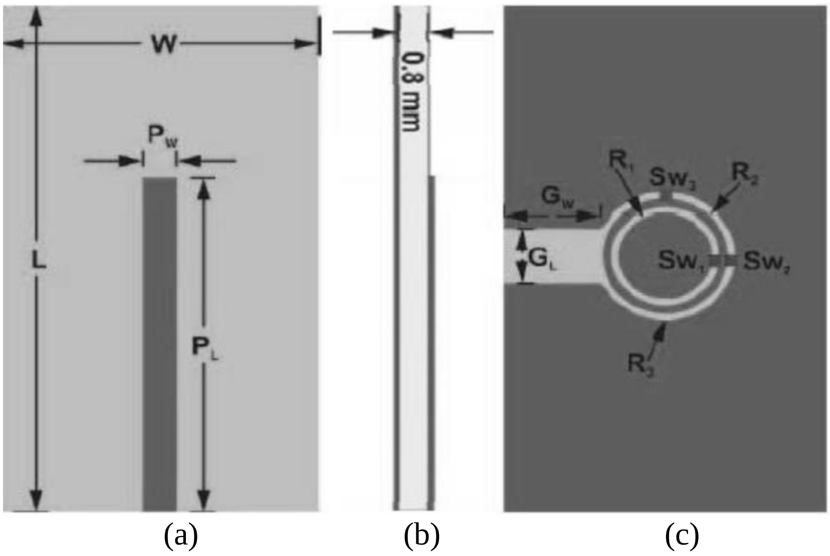


Figure 1 Geometric Configuration of Proposed Multiband Antenna (a) Front View (b) Side View (c) Rear View

2.2 Design of Defected Ground Structure (DGS)

The ground construction for the multiband antenna is seen in Figure 1(c). To create resonance in many frequency bands, a defective ground plane is incorporated on the back side. The wideband antenna element is tuned to function over several narrow and broad frequency bands by using circular gaps in a Defected Ground Structure (DGS). These slots are round in

V

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN: 2456-172X | Vol. 4, No. 3, SEP-NOV 2021
Pages 157- 162| Cosmos Impact Factor (Germany): 5.195
Received: 02.09.2019 Published: 28.11.2019

form and have radii R1, R2, and R3. A rectangular aperture is joined to circular apertures on the ground plane. The defective ground plane enables operation in three frequency bands, with centre frequencies of 3.5, 5.8, and 6.5 GHz.

2. Multiband Re-configurability

The ideal operating frequency spectrum is dictated by the effective dimensions (length and breadth) of the resonant structure, as well as the precise positioning of the structure. The resonance parameters for the appropriate frequency ranges may be found by using equations (1) and (2).

$$W1,2,3 = \frac{c}{sf_0\sqrt{\frac{2}{\varepsilon_r}}} \qquad (1)$$

$$L1,2,3 = \frac{c}{2f_0\sqrt{\varepsilon_r}} \qquad (2)$$

Re-configurability is achieved by using three PIN diodes to switch at the circular slots of the ground plane. Below are three cases:

Case I: When switches Sw1 and Sw2 are in the 'OFF' position, and Sw3 is in the 'ON' position, the outer circular slot with a radius of R3 in the ground acts as a capacitor, while the radiating patch produces an inductive effect. This combination creates a band-pass filter for WLAN 2.5 GHz, as seen in Figure 2.

Case II, dual band operation is accomplished by using WiMAX and C-band frequencies. This is done by setting switches Sw1 and Sw3 to the 'OFF' state, while switch Sw2 is set to the 'ON' state. This configuration increases the capacitive impact of the slot on both sides of the switch connection, enabling dual band operation.

Case III, the capacity to operate on three different frequency bands is accomplished by turning on switches Sw1 and Sw2, and turning off switch Sw3. The Figure 2 illustrates the operational bands, namely WiMAX, WLAN, and C-band.

3. Results and Discussions

3.1 S-parameter and VSWR

The suggested design is implemented using a FR4 laminate with a thickness of 0.8 mm, a relative permittivity of 4.4, and a loss tangent of 0.02, as seen in Figure 2. The findings indicate that the antenna has a favourable return loss (S11 < -10 dB) for various resonant frequency ranges. The frequency range of 2.5/3.5/5.8 GHz is used in applications such as WLAN, WiMAX, and UWB. Figure 2 displays the Voltage Standing Wave Ratio (VSWR) of the suggested design, demonstrating that it meets the necessary parameters (VSWR < 2) for resonating bands.

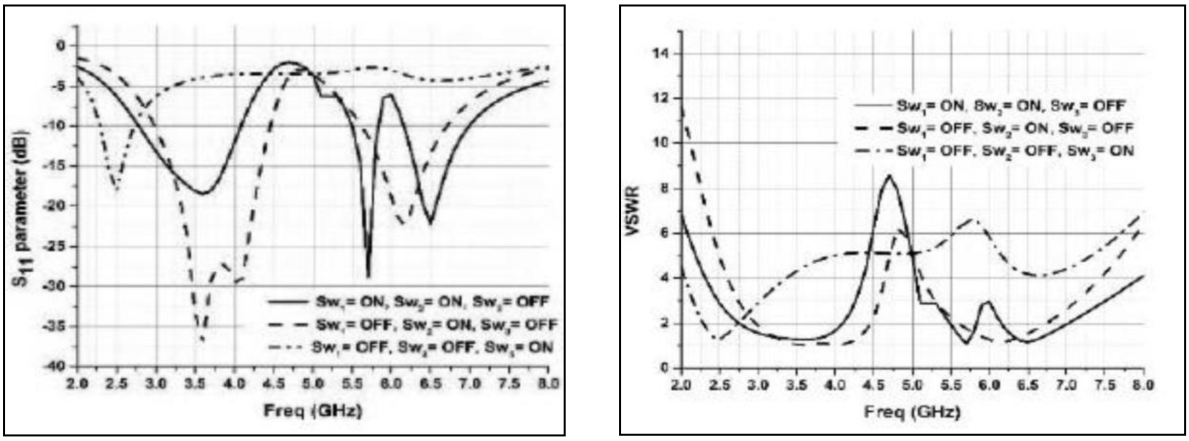
3.2 Radiation Patterns

The radiation characteristics in the horizontal plane (H-plane) and vertical plane (E-plane) of the proposed antenna are shown in Figure 3. The radiation patterns seen in the E-plane are isotropic, meaning they radiate equally in all directions. However, in the H-plane, the radiation patterns are directional, meaning they have a specific direction of maximum radiation.

V

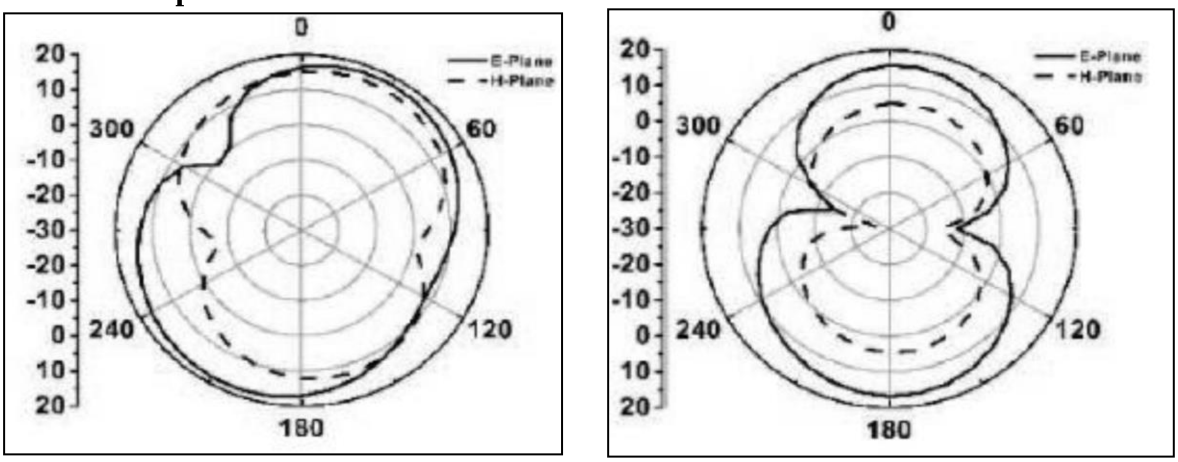
International Research Journal in Global Engineering and Sciences. (IRJGES)

ISSN: 2456-172X | Vol. 4, No. 3, SEP-NOV 2021
Pages 157- 162| Cosmos Impact Factor (Germany): 5.195
Received: 02.09.2019 Published: 28.11.2019

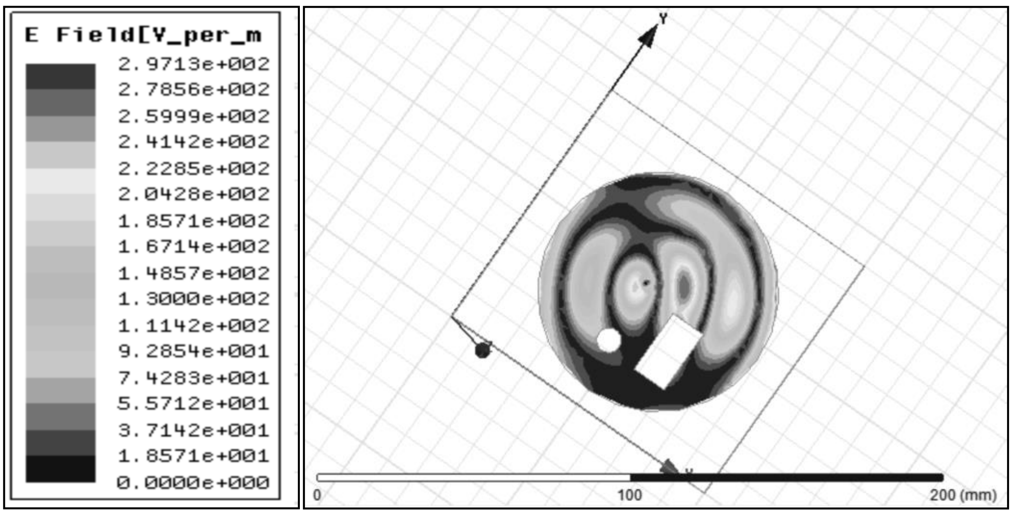


(a) (b)

Figure 2 Simulated Results (a) S11 Parameters of Proposed Antenna Variations (b) VSWR of Proposed Antenna Variations

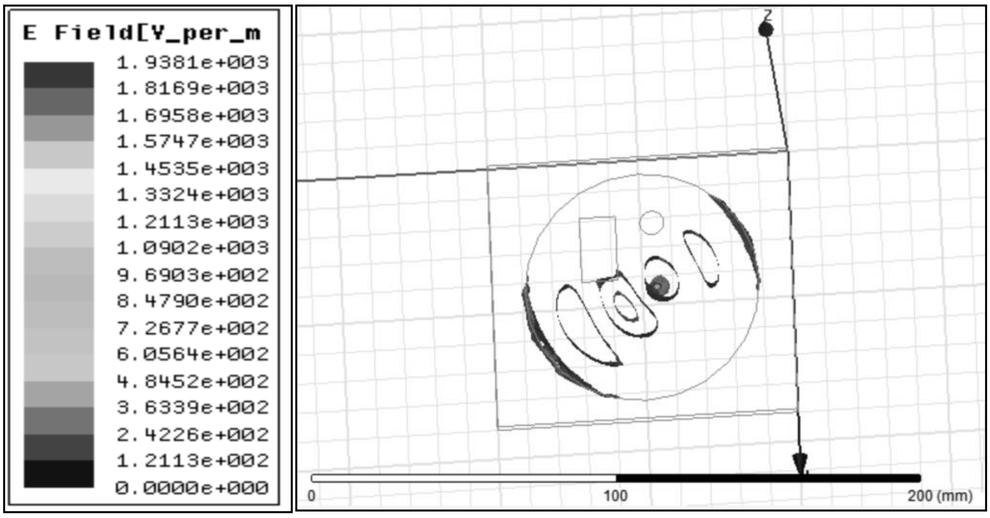


(a) (b)



(c)

V
International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN: 2456-172X | Vol. 4, No. 3, SEP-NOV 2021
Pages 157- 162| Cosmos Impact Factor (Germany): 5.195
Received: 02.09.2019 Published: 28.11.2019



(d)

Figure 3 Radiation Plots (a) at 2.5 GHz (b) at 6.5 GHz (c) Top View (d) Electric Field inside the Plane

4. Conclusion

This article presents a miniaturised multiband antenna that has the ability to change its properties for use in WLAN/WiMAX/UWB applications. Defected ground structure (DGS) enables the achievement of multiband operability. In addition, the ability to be held or adjusted and the ability to be reconfigured for WLAN, WiMAX, and C-band frequency spectrum are also attained with a centre frequency of 2.5/5.7 GHz, 3.5 GHz, and 6.5 GHz correspondingly. It suggests that the suggested antenna design is a suitable choice for a portable wireless communication application.

5. References

[1]. K. Song, Y. Z. Yin and B. Chen Surappa, Triple band open slot antenna with a slit and a strip for WLAN/WiMAX applications, Progress in Electro mamagnetism Research Letters, 2011, 22, 139-146.

[2]. Ting WU, Xiao-Wei Shi, Ping Li and Hao Bai, Tri-band microstrip fed monopole antenna with dual-polarization characteristics for WLAN and WiMAX applications, Electronics Letters, 2013, 49, 1597-1598.

[3]. Banupriya P., Shanmuga Priya, and William, Parametric analysis of a miniaturized slotted patch antenna with meandering line for tri band wireless applications, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Technology and Research, 2014, 2, 1012-1016.

[4]. Sameh M. Zein, Rashid A. Saeed, Raed A. Alsaqour, Rania A. Mokhtar and Alaa A. Yassin, Design of integrated triple band-notched for ultra-wideband microstrip antenna, International Journal of Engineering and Technology, 2013, 5, 504-511.

[5]. Saswati Gosh, Ultra wideband planar crossed monopole antenna as EMI sensor, International Journal of Microwave and Optical Technology, 2012, 7, 247-254.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN: 2456-172X | Vol. 4, No. 3, SEP-NOV 2021
Pages 157- 162| Cosmos Impact Factor (Germany): 5.195
Received: 02.09.2019 Published: 28.11.2019

[6]. K. Chandrashekarappa, Nagabhushana H. M. and C. R. Byrareddy, A novel design of dual band microstrip antenna for wireless application, International Journal of Innovative Technology and Research, 2014, 2, 1012-1016.
[7]. Ebrahim Sailan Alabidi, M. R. Kamarudin, T. A. Rahman, Hashimu Ulediiddi and M. F. Jamlos, Dual-band circular patch antenna for wideband application, IEEE Antennas and Wireless Propagation letters, 2011, 13, 2125-2126.
[8]. Lan Cui, Wen Wu and Da-Gang Fang, Wide-band circular patch antenna with conical radiation pattern, IEEE Antennas and Wireless Propagation Letters, 2014, 11, 1-4.
[9]. Yasser M. Madany, Bandwidth enhancement of compact UWB microstrip patch antenna using EBG structures, IEEE Antennas and Wireless Propagation Letters, 2013, 13, 402-403.
[10]. Ahmed Khidre, Kai-Fong Lee, Fan Yang and Atef Z. Elsherbeni, Circular polarization reconfigurable wideband e-shaped patch antenna for wireless applications, IEEE Transactions on Antennas and Propagation, 2013, 61, 960-963.
[11]. Ojaroudi Parchin N, Jahanbakhsh Basherlou H, Al-Yasir YI, Abd-Alhameed RA, Abdulkhaleq AM, Noras JM. Recent developments of reconfigurable antennas for current and future wireless communication systems. Electronics. 2019 Jan 26;8(2):128.
[12]. Habibi MA, Nasimi M, Han B, Schotten HD. A comprehensive survey of RAN architectures toward 5G mobile communication system. Ieee Access. 2019 May 28;7:70371-421.
[13]. Ben Hamadi H, Ghnimi S, Latrach L, Benech P, Gharsallah A. New Design of Multi-Band PIFA Antenna with reduced SAR for mobile and wireless applications. Wireless Personal Communications. 2020 Nov;115:1211-26.
[14]. Ojugo AA, Eboka AO. Mitigating Technical Challenges via Redesigning Campus Network for Greater Efficiency, Scalability and Robustness: A Logical View. International Journal of Modern Education & Computer Science. 2020 Dec 1;12(6).