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Dual band F-shaped with defected ground structure Monopole Antenna for Wi- Fi/WiMAX/C-Band Applications

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ABSTRACT

In this article, a dual band antenna for WiMAX, and c-band applications are designed. The antenna structure comprises of a DGS and a rectangular monopole with a microstrip feedline for excitation. The suggested antenna operates over two bands, with resonance at 2.3 GHz for the WiMAX and at 5 GHz for the WLAN system (IEEE 802.11a standard) and c-band application. The F- shaped antenna with DGS is utilized to enhance the antenna's bandwidth. Here FR-4 substrate is used. The antenna has a compact size, that is 40×28×1.6 mm3. HFSS is used to simulate the antenna. The proposed antenna is assessed using a number of antenna parameters, including return loss, gain, current distribution, VSWR, and radiation pattern.

Keyword-
Monopole Antenna, DGS, Dual Band, FR-4 Substrate, WiMAX, WLAN

1. INTRODUCTION

Wireless communication systems have become an integral part of modern society, with increasing demands for high-speed data transmission and reliable connectivity. Antennas are a crucial component of these systems, as they determine the quality and efficiency of signal transmission. Microstrip antennas, in particular, have gained considerable attention due to their advantage such as low miniaturize profile, lightweight, and affluence of integration with PCB [1-4].

"An Asymmetric Geometry of Defected Ground Structure for Rectangular Microstrip was proposed by Chandrakanta Kumar"[5]. One of the difficulties in designing microstrip antennas is achieving dual-band operation to support multiple wireless communication standards simultaneously. This can be achieved by incorporating defected ground structures (DGS) that create stop bands at certain frequencies and improve the antenna's bandwidth. Among various DGS configurations, F-shaped DGS has been shown to provide good impedance matching, radiation efficiency, and gain [6]-[8].

Naser Ojaroudi Parchin proposed a F-shaped antenna with dimension 38×45×1.6 mm^3 for RFID application [9]. Meng-Shuang Wang proposed an F-shape antenna for GPS Applications [10]. This paper proposed a dual-band F- shaped DGS microstrip monopole antenna that operates at 2.3 GHz and 5 GHz for Wi-Fi and WiMAX applications, respectively, as well as at C-band for satellite communication [11]. Due to its low cost and advantageous electrical qualities, the FR4 substrate which serves as the substrate for the antenna and has a loss tangent of 0.02 is frequently utilized for printed circuit boards [12-15].

HFSS simulation software is used to examine the performance parameters of the proposed antenna, including return loss, radiation pattern, and gain. The antenna's compact size, low profile, and good radiation characteristics make it suitable for integration into wireless communication devices. This proposed antenna is better than the existing antenna.

2. ANTENNA DESIGN

The suggested antenna, which is represented by a Lsub×Wsub substrate in Fig. 1, is shown. The suggested monopole antenna consists essentially of a rectangular monopole, a microstrip feedline for excitation, and a deformed ground plane construction. A Lg×Wsub ground is put on the substrate's base ground. To enhance the outcomes, a strip with the dimensions Wc1×Lc1 is added to the antenna's bottom side. To improve the outcomes, a Wc2 cut is lastly added to the ground side of the antenna. Figure 2 depicts the antenna from the top and bottom. A feed line of 50Ω(Wf×Lf) is used for centrally feeding the antenna. On the other side of the substrate is a conducting ground plane with the dimensions Wsub width and Lg length. The antenna is connected to a 50 SMA connector to broadcast signals. Table 1 contains the parameter values for the antenna design. The S11 of the suggested antenna is shown in Fig. 3 The proposed antenna has a decent return loss in the lower band, which is -20 dB, and in the higher band, which is -33 db.

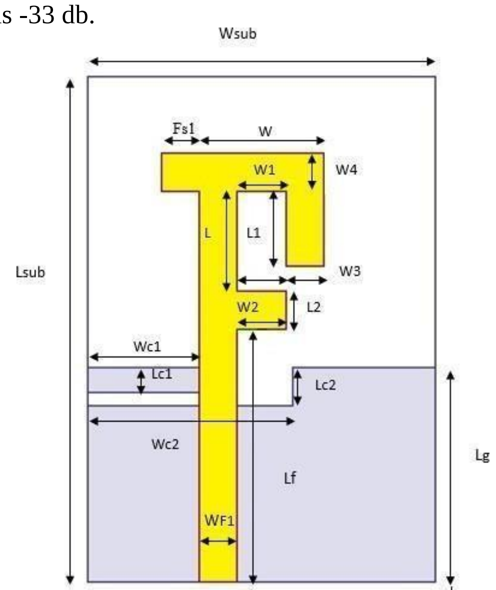
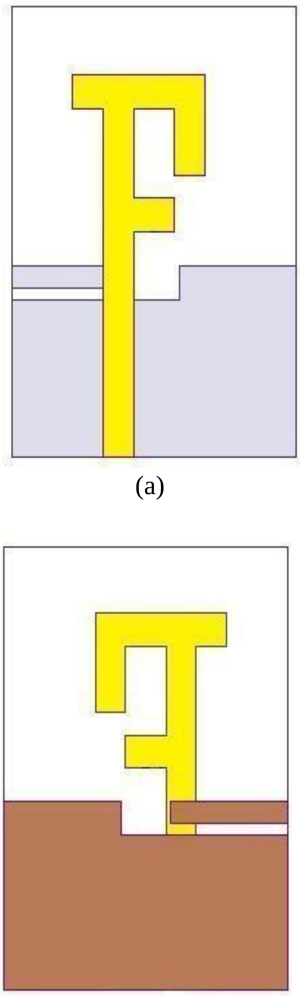


Fig. 1 Proposed Antenna

Table. 1 Parameter of designed antenna

Parameter	Value(mm)	Parameter	Value(mm)	Parameter	Value(mm)
Wsub	28	Lsub	40	Hsub	1.6
WF1	3	Lf	20	W	10
W1	4	W2	4	L	8
L1	6	L2	3	L3	3
L4	3	Lg	17	W3	3
Wc1	10	Lc1	2	Wc2	15
Lc2	2	Fs1	3		



(a)

(b)

Fig. 2 (a) Top (b) Bottom view

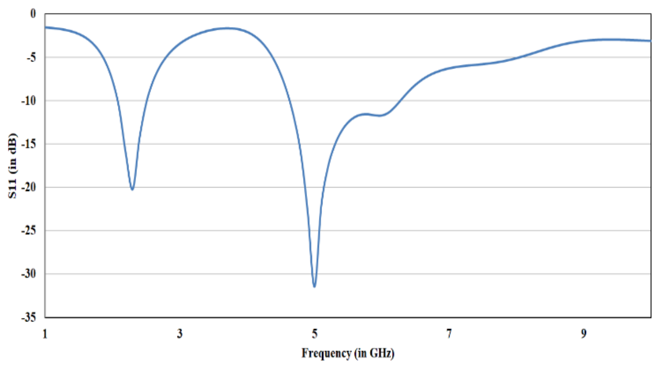


Fig. 3 Return Loss at 2.3 and 5 GHz.

3. PARAMETRIC ANALYSIS

For make antenna optimum the parameters Lg, and Fs1, and WF1 are select to investigate, that results are shown in Fig. 4,5 and 6. Fig. 4 illustrate the effects of Lg. In this Lg is varied from 17 to 19 mm. Even after varying the length of the ground the graph does not show much difference, the length of ground is taken as 17mm. Fig. 5 illustrates the return loss of antenna at different values of Fs1.In this the Fs1 varies from 3 to 5 mm, Fs1=3mm the antenna has optimum return loss.

Fig. 6 depicts the antenna return loss for various WF1 values. In this the value of WF1 is varied from 3mm to 4mm. And we get better return loss at WF1=3mm which is of the proposed antenna.

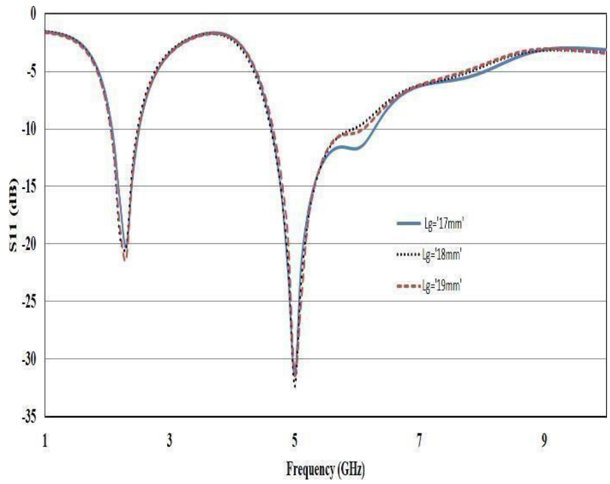


Fig. 4 Return Loss for Various values of Lg

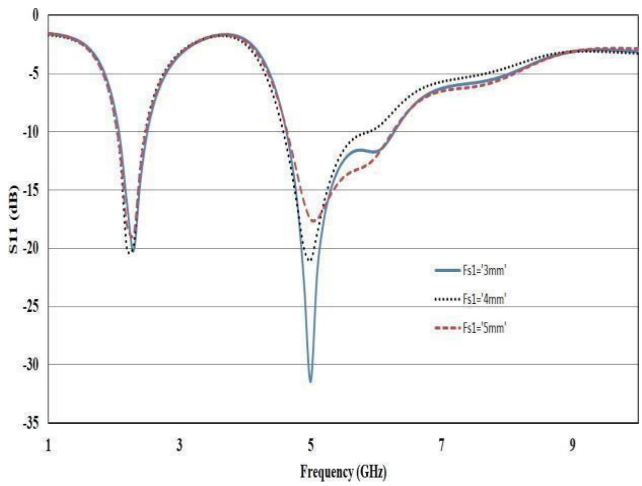


Fig. 5 Return Loss for various values of Fs1

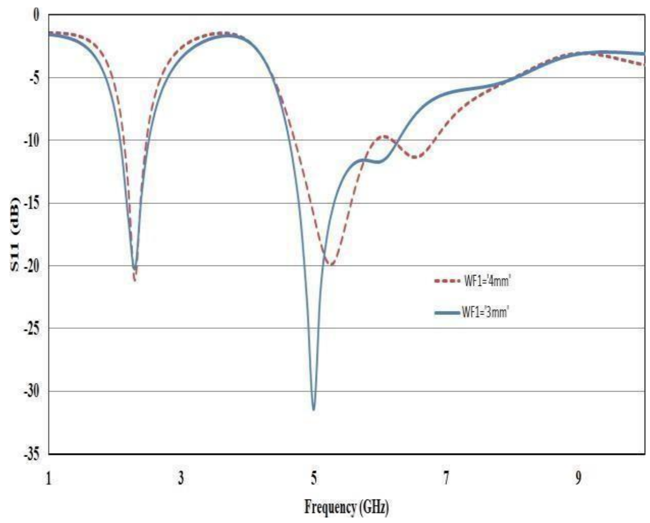


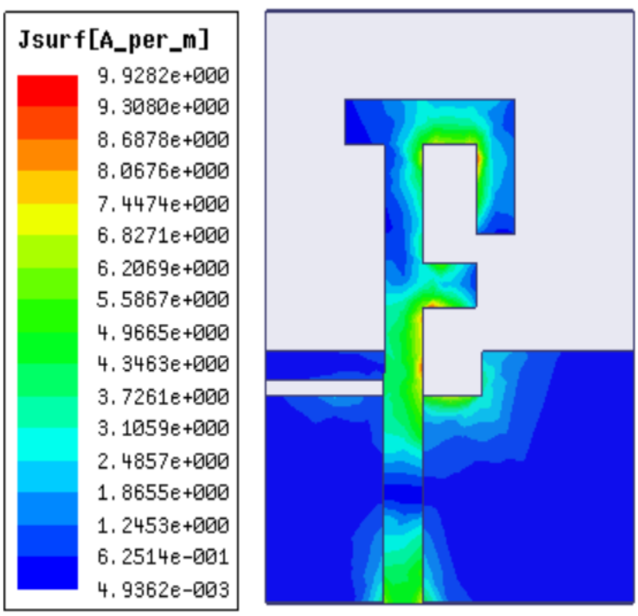
Fig. 6 Return Loss for various values of WF1

4. RESULTS AND DISCUSSION

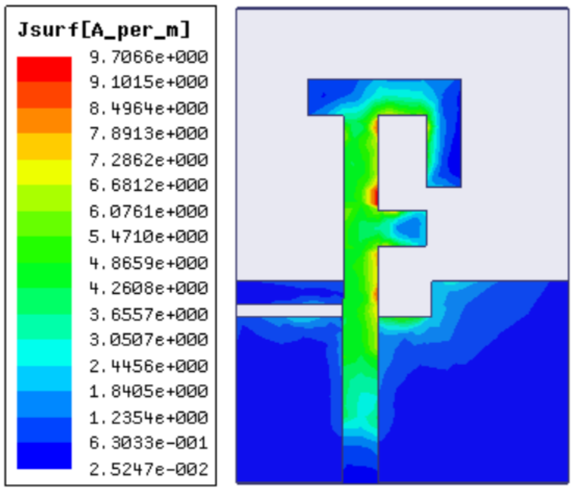
Fig. 7(a) and (b) display the proposed antenna's current distribution. Fig. 7(a) demonstrates the current distribution in the antenna at lower frequency 2.3 GHz. The ground plane of the antenna has the highest current flow, whereas the top and side of the antenna's f-shape have lower current flows. The highest current flows in the ground as well as at the top and other side of the F-shaped strip at 5 GHz's upper band frequency.

The antenna's radiation patterns at 2.3 GHz and 5 GHz for the H-plane and E-plane, respectively, are shown in Figures 8(a) to(d). The E-plane antenna radiates in a single direction and forms a small lobe at 2.3 GHz, as shown in Fig. 8(a). Fig. 8(b),8(c) and (d) shows a bidirectional radiation pattern for both plane.

Fig. 10 shows how the antenna's VSWR is displayed. VSWR between 1 to 5 is considered good for perfect transmission. Here for both resonant frequency VSWR is greater than 1 and less than 5. According to simulation result, the antenna provides a sufficient gain of 5.4 dB at 2.3 GHz and 3.5 dB at 5 GHz, as shown in Fig. 9.

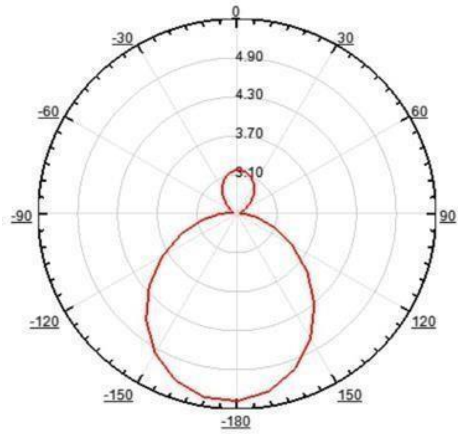


(a) Frequency = 2.3 GHz



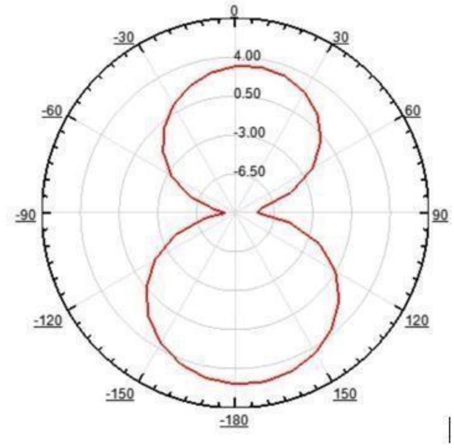
(b) Frequency = 5 GHz

Fig. 7 Current distribution of the designed antenna



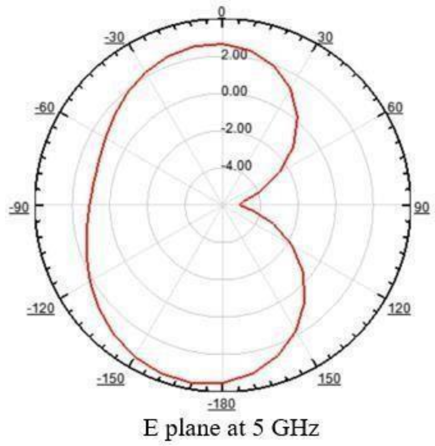
E plane at 2.3 GHz

(a)

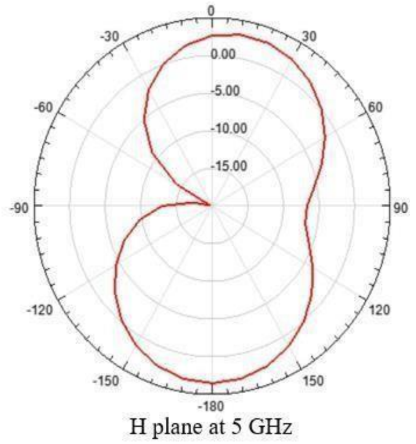


H plane at 2.3 GHz

(b)



(c)



(d)

Fig. 8 Radiation Pattern of the designed antenna

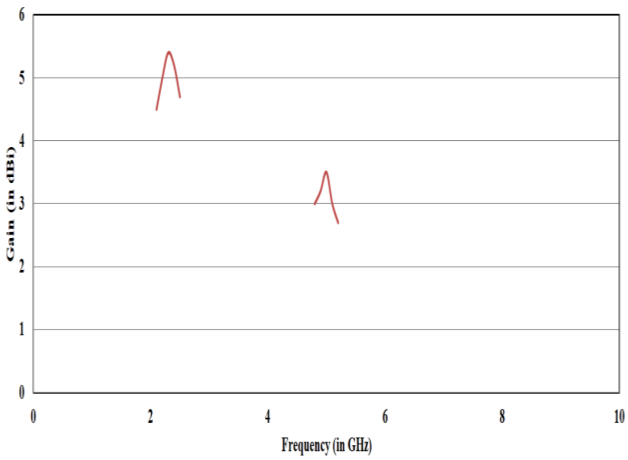


Fig. 9 Gain vs Frequency plot

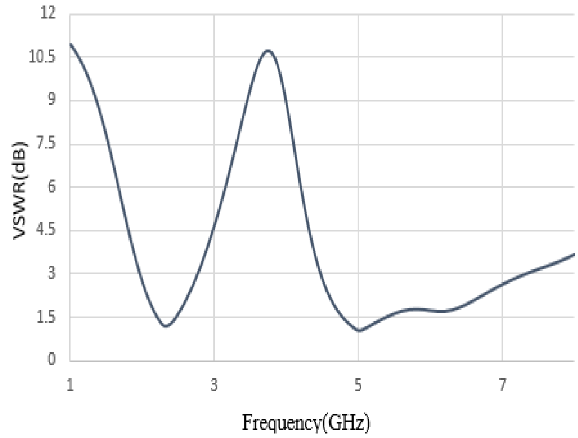


Fig. 10 VSWR of designed antenna

5. CONCLUSION

A dual-band antenna design has been proposed for applications in Wi-Fi, WiMAX, and C-band frequency ranges. The antenna is constructed using a monopole configuration with an F-shaped radiation patch, which has been carefully analyzed to achieve the desired dual-band functionality. The key focus of the study has been to understand and evaluate the attributes of the antenna. The antenna exhibits an impedance bandwidth spanning from 2.2 GHz to 2.6 GHz and from 4.8 GHz to 5.5 GHz. This wide bandwidth ensures that the antenna can effectively operate within these frequency ranges without significant signal degradation. Additionally, the antenna demonstrates favorable radiation properties, which are crucial for the efficient transmission and reception of signals.

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