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Design and Fabrication of a Compact G-shaped Dual Band Antenna for WLAN/Wi-MAX and RFID Applications

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Abstract—In this paper, a G-shaped dual-band monopole antenna with a shorted strip fed by a coupling microstrip line for wireless communication in the wireless local-area network (WLAN) band has been designed and fabricated. The proposed antenna can provide two separate impedance bandwidths of 510MHz (2.29GHz-2.8GHz) and 1.92GHz (4.73GHz-6.65GHz) respectively. Consistent omnidirectional radiation patterns have been observed in both the frequency bands. The antenna is simple in design and compact in size. It also exhibits appropriate gain characteristics (>2.8dBi) in the RFID and WLAN/Wi-MAX frequency regions.

Index Terms— Dual band antenna, Wireless, WLAN, Wi-MAX, RFID.

1 Introduction

With the increase of demand for data usage, internet connectivity and networking, new methods have emerged out making older methods obsolete. Notable structures among them are: CPW-fed dual frequency monopole antenna [1], dual band CPW-fed strip-sleeve monopole antenna [2], CPW fed L-shaped slot planar monopole antenna for triple band operation [3], internal planar monopole for mobile phones [4], dual-band planar branched monopole antenna [5], dual band U-slot antenna [6], etc. Similarly, many compact antennas for RFID application at 5800 MHz are available in the literature such as CPW-fed folded slot [7], T-shaped folded slot monopole antenna [8], F-shaped CPW-fed monopole antenna [9], CPW-fed dual folded strip [10], semicircular CPW fed folded slot antenna [11] etc. Our intension is here to design a compact monopole antenna, which can be used simultaneously for WLAN as well as RFID systems. One such emerging technology that we are going to focus here is Wi-MAX, a wireless communication standard (IEEE 802.16 family of network standards [12], designed to provide a data rate of 30-270Mbps [13]. There is no uniform global licensed spectrum for Wi-MAX, however the Wi-MAX forum has published there licensed spectrum profiles: 2.3GHz, 2.5GHz and 3.5GHz, in an effort to drive standardization and decrease cost.

In this paper, a simple and compact G-shaped antenna with a shorted strip fed by a coupling microstrip line feed antenna is presented, and discussed for RFID and WLAN/Wi-MAX. The proposed antenna exhibit dual band characteristics with the lower resonant band of 2.29-2.8GHz and the upper band of 4.73-6.65GHz. These bands are suitable to cover the industrial Scientific Medical band at 2.4-2.484GHZ, Radio Frequency Identification (RFID) band at 2.45GHz, Wireless Local Area Network at 2.4-2.484GHz, and Wi-MAX at 5.2-5.8GHz.

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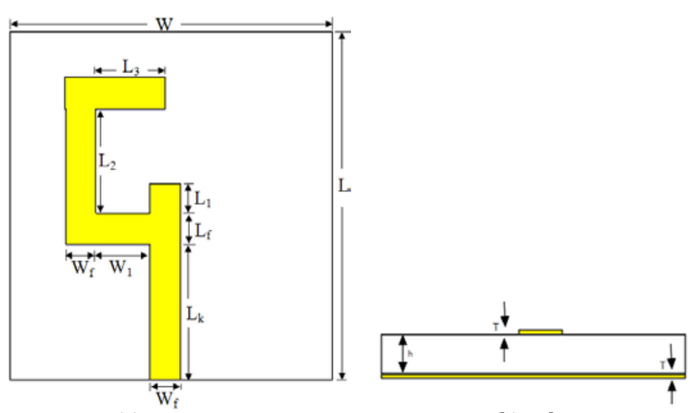
2 The Proposed Antenna Design and Fabrication

This proposed antenna geometry has been shown in figure 1 and 2. It is designed with FR4 as a substrate material with size of 30×38 mm² with substrate thickness h of 1.6 mm, and dielectric constant of 4.4 with loss tangent of 0.02. The width of the micro-strip feed line W_f is 3.06 mm to achieve 50Ω characteristic impedance. The dimension for ground plane is $W \times lg$. On the front surface of the substrate, a modified rectangular patch of similar to the shape of alphabet G is printed. Due to this G-shaped structure, it is found that much enhanced impedance bandwidth can be achieved.



(a) Top view (b) side view

Figure-1 The proposed antenna design

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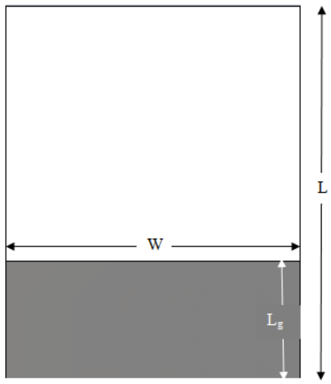


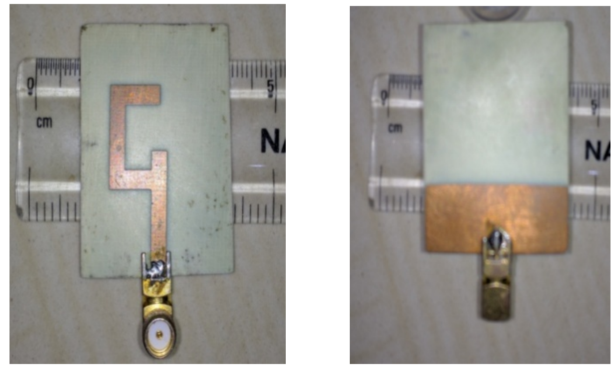
Figure-2 Bottom view of the antenna design

The dimensions of the proposed G-shaped antenna are shown in Table-1.

TABLE-1
PARAMETERS OF DUAL-BAND ANTENNA

Parameters	Values (in mm)
L_1	2.9
L_2	5.4
L_f	3
L_k	13
H	1.6
L	38
L_3	10
L_4	7
L_g	12
T	0.035
W	30
W_f	3.06

The G-shaped antenna studied in the paper is fabricated using the photolithographic technique. Photolithographic technique is a chemical etching process by which the unwanted metal regions of the metallic layer are removed so that the intended design is obtained. The selection of substrate material for any microstrip patch antenna is the essential part of the design. FR4 has been chosen as substrate material to fabricate the proposed antenna due to its low cost and easy availability. Figure 3 shows the top view and the back view of the fabricated G-shaped antenna.



(a) **(b)**

Figure- 3 Top view and back view of the fabricated antenna design

3 SIMULATED RESULTS

Simulation of the antenna structure was performed using the transient solver in CST Microwave Studio software [14]. The simulated return loss of the proposed design is shown in figure 4. Two resonant peaks are achieved at 2.5GHz and 5.5GHz which demonstrate that the antenna is having a dual–band characteristisc. The simulated return loss of -16.3dB and -25.6dB is obtained at 2.2GHz and 5.5GHz resonant frequency respectively. The bandwidth defined for -10dB return loss is 510MHz and 1.92GHz at 2.4GHz and 5.5GHz respectively. In fact, the achieved bandwidths of all together cover WLAN standards in the 2.4/5.2/5.8 GHz bands, Bluetooth standard in the 2.4GHz band, and Wi-MAX and RFID standards in the 5.5 GHz band.

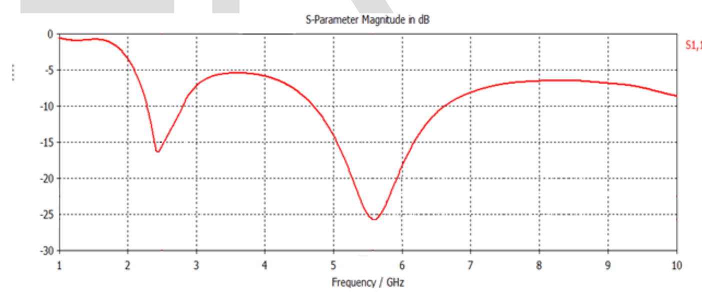


Figure-4 Simulated return loss for the G-shaped antenna design

Radiation pattern is a mathematical function or graphical representation of the radiation properties of the antenna as a function of space coordinates. Radiation properties include power flux density, radiation intensity, field strength, directivity phase or polarization. The radiation patterns of the proposed antenna at 2.5 GHz and 5.5 GHz are shown in figures 5 and 6 respectively.

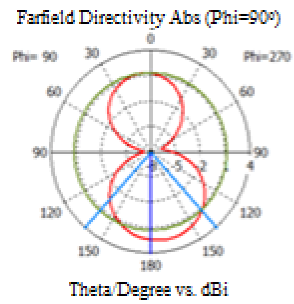


Figure -5 Simulated radiation pattern at 2.5 GHz frequency

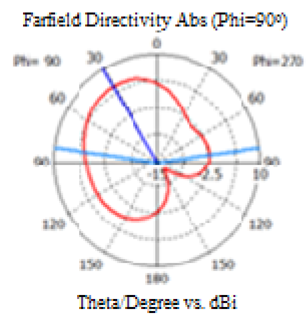


Figure- 6 Simulated radiation pattern 5.5 GHz frequency

Smith chart pattern for the proposed antenna design is shown in figure 7. It shows the complex reflection coefficient in polar form for arbitrary impedance. The center of the smith chart circle corresponds to reflection coefficient (Γ) which when equals to zero means a perfect impedance match. The smith chart also shows the dual band characteristic of the proposed antenna design.

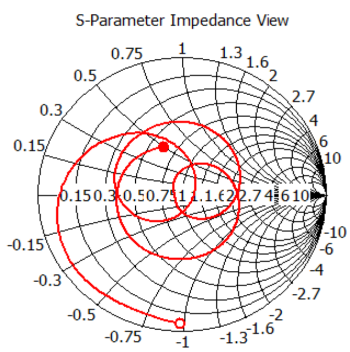


Figure -7 Smith chart for the proposed antenna design

4 COMPARISION OF SIMULATED AND MEASURED RESULTS

The measurement of return loss of the G-shaped antenna was carried out using Vector Network Analyzer (VNA). ROHDE & SCHWARZ ZVA 40 VNA used in measeurment is sophisticated equipment capable of making rapid and accurate measurements in frequency and time domain [15]. The Vector Network Analyzer can measure the magnitude and phase of the S-parameters. Its built in signal processor analyses the transmit and receive data and displays the results in many plot formats. Figure 8 shows the measured and simulated return loss of G-shaped antenna. It is clearly shown that the simulated and measured results are in very good agreement.

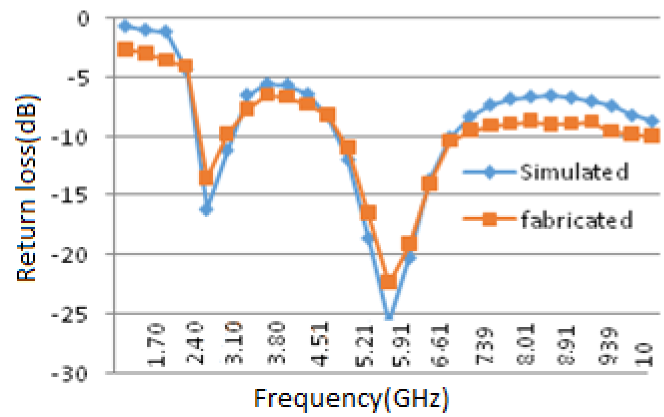


Figure- 8 Simulated and measured return loss of G-shaped antenna

5 CONCLUSION

A compact G-shaped microstrip feed antenna producing dual resonance frequencies with enhanced frequency diversity has been designed and fabricated. Satisfactory dual-band operations for WLAN/Wi-MAX and RFID applications have been achieved. It provides broadband impedance matching, consistent radiation pattern, and appropriate gain characteristics in the RFID and WLAN/Wi-MAX frequency range.

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