A Compact U-slot Dual-Band Antenna for WLAN/Wi-MAX and RFID Applications

Avinash Garhwal, U. S. Modani, Raj Kumar Sharma

Abstract— In this paper a U slotted 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 is studied. The proposed antenna can provide two separate impedance bandwidths of 927MHz(2.071GHz-2.998GHz) and 6879MHz(5.1760GHz-5.8639GHz) respectively. Consistent omniderectional radiation patterns have been observed in both the frequency bands 2.4 GHz and 5.5 GHz. The proposed antenna is simple in design and compact in size. It exhibits broadband impedance matching, consistent omnidirectional patterns and appropriate gain characteristics (>2.8 dBi) in the RFID and WLAN/Wi-MAX frequency regions.

Index Term— Dual band antenna, Wireless applications, WLAN, Wi-MAX, RFID,CST Microwave Studio.for research paper title.

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], etc. Similarly, many compact antennas for RFID application at 5800 MHz are available in the literature such as CPW-fed folded slot [6], T-shaped folded slot monopole antenna [7], F-shaped CPW-fed monopole antenna [8], CPW-fed dual folded strip [9], semi circular CPW fed folded slot antenna [10] 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 [11], designed to provide a data rate of 30-270Mbps [12]. 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 U-slotted 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 (2.0-2.367)GHz and the upper band of (5.1335-5.8065)GHz. These bands are suitable to cover the industrial Scientific Medical (ISM 2.4-2.484GHZ), Radio Frequency Identification (RFID 2.45 GHZ), Wireless Local Area Network (WLAN 2.4-2.484 GHZ), and Wi-MAX(5.2-5.8 GHz).

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2 The Proposed Antenna Model

The geometry of patch of the proposed antenna is shown in figure 1. Figure 1 shows the front view of the structure which comprises of three elements. The first element is designed as a rectangular with U-slot. Dimensions of rectangular shape is ($W_2 \times L_3$) and dimensions of U-slot is ($W_1 \times l_u$), while dimension of below element is ($W_1 \times l_2$) with a cut of W_c on the both side separated by W_i=1.5mm. The antenna is excited using an offset 50 ohm microstrip line. The dimensions of the microstrip line are ($Wt \times l_1$). The dimension for ground plane is ($W \times l_g$).

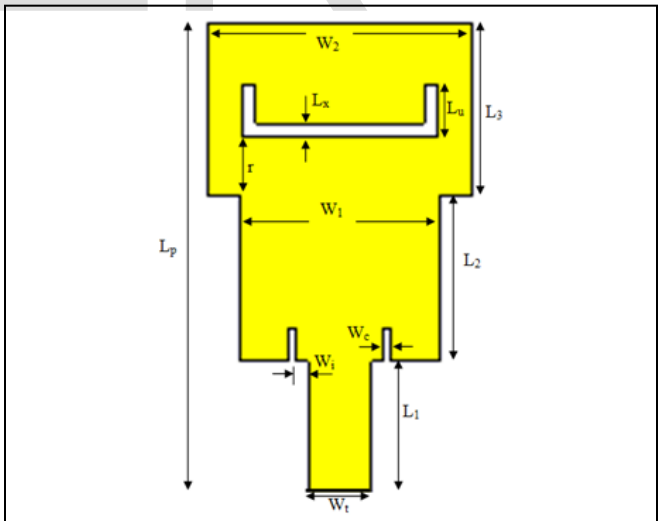

Fig. 1. Top view of antenna

The dimensions and specification of the proposed antenna are as follows. Refer figure 1.

TABLE 1

PARAMETERS AND VALUES OF DUAL-BAND ANTENNA

Parameter	Value(mm)	Parameter	Value(mm)
W	50	L_g	10
L	50	W_i	1.5
W_2	20	W_u	14
W_1	15	L_u	3
L_2	10	r	5
W_c	1	L_x	1
W_t	4.75	h	10
L1	8	L3	10

3 ANALYSIS

The proposed U-slotted dual–band antenna has been designed to resonate with the lower frequency is located at 2.4 GHz. After optimizing the different antenna parameters, the proper design has been chosen to get the required results with the dual-band characteristics.

The antenna is fed by a microstrip center lined technique. The radiator and ground plane are on the two opposite faces of flame retarding (Rogger 5880RT) substrate having thickness of 1.575mm with relative permittivity and loss tangent 2.2 and 0.02 respectively.

4 RESULTS AND DISCUSSION

The simulated return loss of presented structure is shown in figure 2. Two resonant peaks achieved at 2.4GHz and 5.5GHz demonstrate that the antenna is showing a dual –band character. The bandwidth defined for -10dB return loss is about 927 MHz and 6879 MHz 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 2.4 GHz band, and Wi-MAX and RFID standard in the 5.5 GHz band. The radiation pattern of the proposed antenna that shows both the E and H-planes patterns for 2.4GHz frequency is represented in fig. 3 and for 5.5GHz in fig. 4. Smith chart pattern for proposed antenna is represented in fig. 5. With U-slot a dual band characteristic was obtained. Further, by the use of side small cut in below structure, the desired frequencies were obtained with wide impedance bandwidth. This signifies that with U-slot two resonances were excited and the sides cut considerably improved the matching conditions for lowest (2.071GHz-2.998GHz) and highest (5.1760GHz-5.8639GHz) bands. To further examine the excitation mechanism, average surface current distributions obtained from CST simulation on patches and ground plane for optimized antenna were studied. A large surface current was observed over the patch and along the microstrip line at both the resonant frequencies. At lower frequency the current was more concentrated along one of the parallel arms of U-slot which displays current distribution on ground at 2.43 GHz and 5.52 GHz, whereas at higher frequency current was more distributed along the periphery of other arm of U-slot and side cut. The effect of various dimensions of U-slot on return loss was also examined.

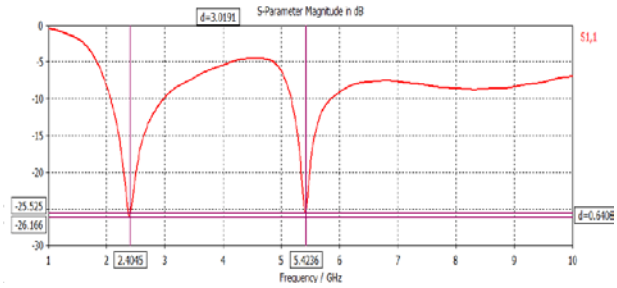

Fig.2. Simulated Return loss(dB against Frequency for Proposed Antenna with U-slot and with no defect

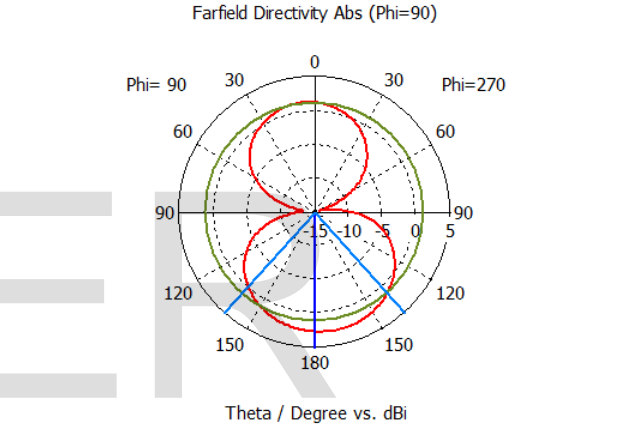

Fig.3. Simulated Radiation Pattern for proposed Antenna at 2.40 GHz frequency.

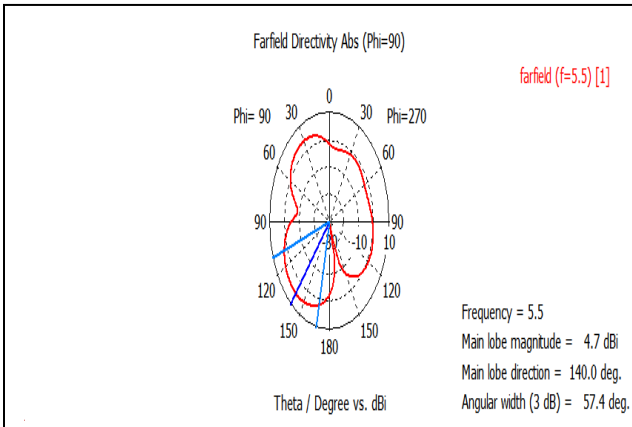

Fig.4.Simulated Radiation Pattern for proposed Antenna at 5.52 GHz frequency

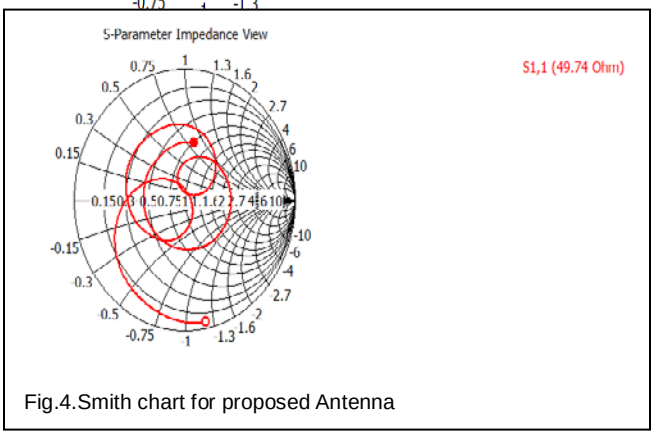

Fig.4.Smith chart for proposed Antenna

5 Conclusion

A compact U-slot microstrip feed antenna producing dual resonance frequencies with enhanced frequency diversity. Satisfactory dual-band operations for WLAN/Wi-MAX and RFID applications is easily achieved by the U-slotted configuration. The proposed antenna is simple to design and compact in size. It provides broadband impedance matching, consistent radiation pattern appropriate gain characteristics in the RFID and WLAN/Wi-MAX frequency range.

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