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Edge Chamfered Novel Miniaturized Patch Antenna with U Slots for WLAN, WIMAX Applications

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Abstract

In this paper, the design of a Wide band, compact, miniaturized patch antenna for WLAN, WIMAX applications is presented. The conventional patch antenna is designed to resonate at 2.785 GHz. The proposed rectangular patch is initially modified by chamfering the lower radiating edge (to make it much more compact). Further, the proposed antenna has two U shaped slots etched over the patch and a U shaped slot on the microstrip feed line. Besides this, a spiral resonator is also etched over its ground plane. This antenna has dual resonances one at 2.476 GHz and another at 2.54 GHz with a gain of 4.5 dB, 5.09 dB respectively. The percentage of miniaturization is found to be 27.38%, 20.89% for the two band of resonances.

Keywords: *Rectangular microstrip patch antenna (RMPA), Slots, Miniaturisation, Linear Polarization, WLAN, WIMAX*

INTRODUCTION

Growing wireless technology demands for planar, printed, light weight antennas cheaper in cost as well as with multifunctioning capabilities. One such antenna is Microstrip patch antenna (MPA). The main drawback of such antenna is narrow bandwidth and surface waves [1–3]. Over years, many attempts were continuously carried out by researchers to improve the gain and band width of these antennas. As current proposal is for wireless application particularly WLAN, WIMAX, Federal Council article is referred [4]. Many researchers have created slots on MPA geometry to yield notches and ultra wide band proposals [5–21]. These papers give an idea about Decreased Grounded structures and the stop band features, achieved by creating slots on patch as well as on grounds.

To make it suitable for onboard applications, slots were also created for obtaining miniaturization in patch size. Many researchers have proposed C shaped, E shaped, U shaped slots in miniaturizing the antenna [22–30]. In this paper, a modified patch antenna with two slots on patch and a spiral etch on the ground is presented.

DESIGN OF RECTANGULAR MICROSTRIP PATCH ANTENNA (RMPA)

RMPA can be fed by direct or Indirect feeding mechanisms, of which inset fed is easier to achieve; hence it is chosen in this design to create linear vertical polarization. Initially the Microstrip patch antenna is designed to resonate at 2.785 GHz. The design equations are taken from [1]. A flexible substrate with ε_r of 2.2 and thickness of 120 mils is used in this modeling. The top view of model is shown in Figure 1.

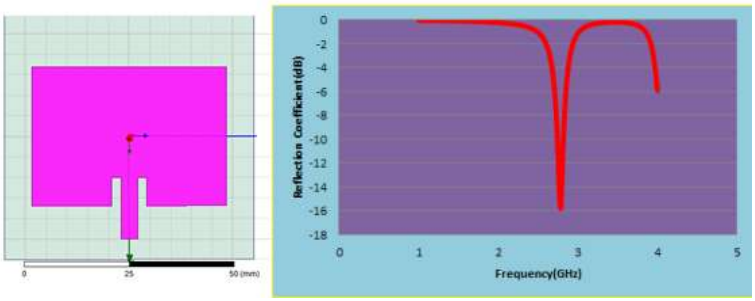

Fig. 1: *Microstrip Patch Antenna Model and its Return Loss Characteristics.*

The antenna resonates at 2.785 GHz with a return loss of -15.77 dB as in Figure 1. The gain is found to be 7.5675 dB which is shown in Figure 2. The pattern is omnidirectional with a difference of -40 dB between co and cross polarization levels.

Fig. 2: *Polar Plot (Gain) of Conventional Patch Antenna.*

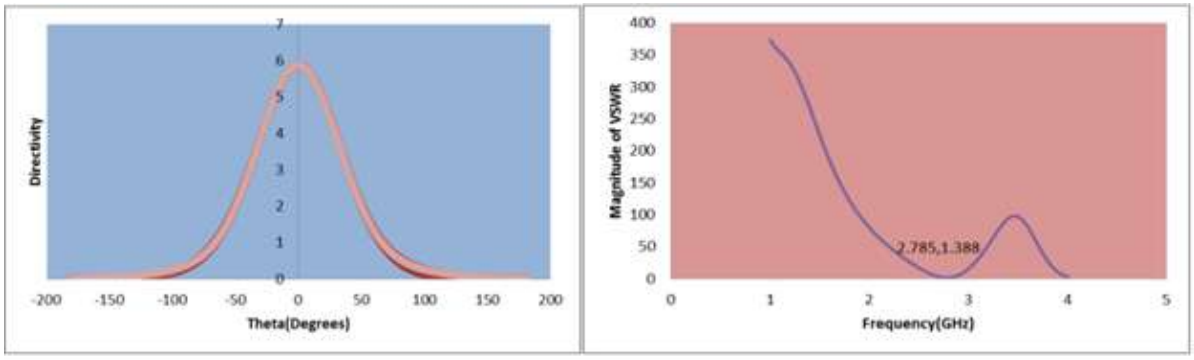

Fig. 3: *Directivity, VSWR of Conventional Patch Antenna.*

At resonance, the directivity is found to be 5.8 while the VSWR is found to be 1.388. This can be noted from the Figure 3. The antenna parameters are also tabulated in Table 1 for the sake of clarity.

Table 1: *Parameters of Antenna.*

Antenna Parameter	Value	Unit
Max U	0.45452	W/sr
Gain	7.5675	dB
Radiation Efficiency	99.887%	
Directivity	5.8	
VSWR	1.388	

The lower edge of patch antenna is chamfered. Further, two U shaped slots with lengths L1, L2, L3, L4, L5, L6 are created on the upper side of the patch. Another U shaped slot is created on feeder while a spiral etch of two turn is created on ground. The proposed patch is targeted for WLAN, WIMAX applications. The resonant frequency value is primarily affected by the perimeter of the slots.

DESIGN OF PROPOSED PATCH

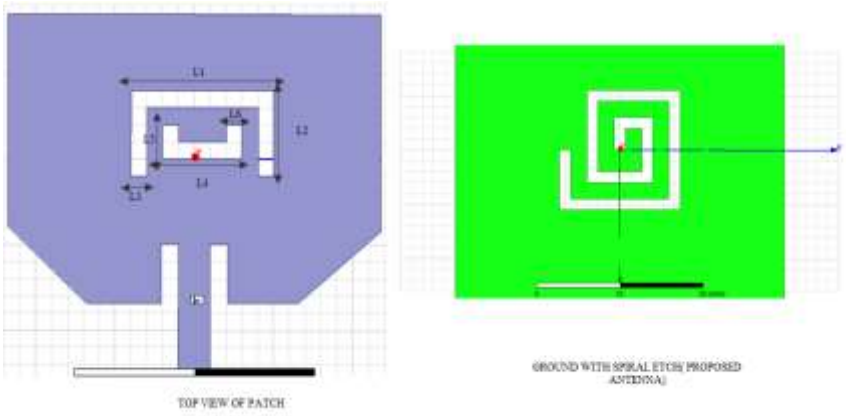

Fig. 4: *Proposed Antenna Model with U Slots on Patch and Spiral Etch on Ground (Top View).*

Keeping this in mind the slots dimensions are fixed initially and they are optimized further with the help of e.m simulator for various feed positions. The optimized dimensions of the slots on patch, feed as well as the spiral etch on ground are all tabulated in Table 2. The proposed antenna model (Top, Ground plane view) is given in Figure 4 while reflection coefficient characteristics are shown in Figure 5.

Table 2: *Optimized Dimensions of the Proposed Patch Antenna.*

No.	Dimensions of Proposed MPA	Value (mm)
1	Ground	0.55λ×0.55λ
2	Substrate	3.048
3	Patch	0.3942λ × 0.3197λ
4	Upper U slot L1,L2,L3	18,10,2
5	Lower U slot L4,L5,L6	10,4,2
6	U shape slot on feed	1.5,1,0.5
7	Spiral turns	2
8	Width of spiral	2
9	Distance	5
10	Thickness of spiral	0.0025

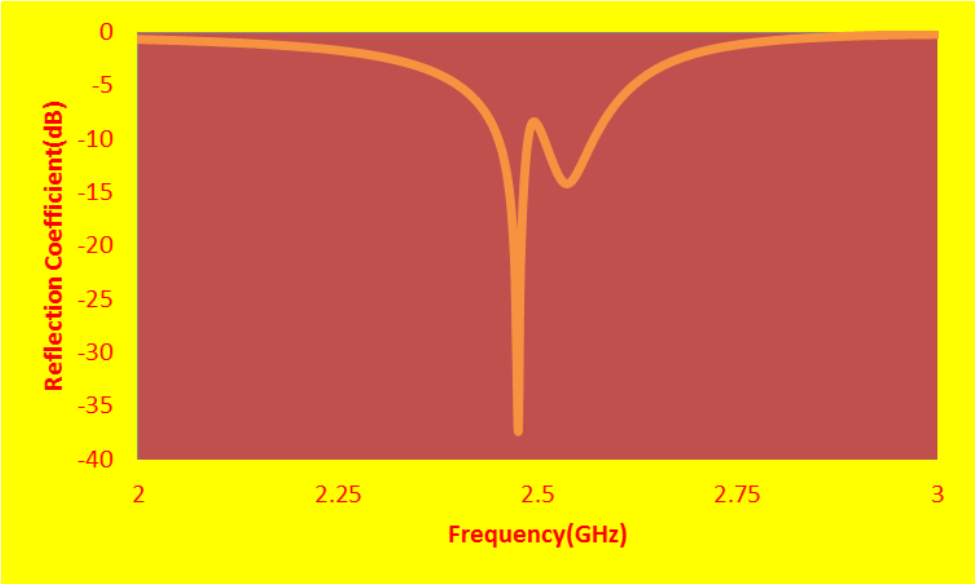

Fig. 5: *Return Loss Characteristics of Proposed Antenna.*

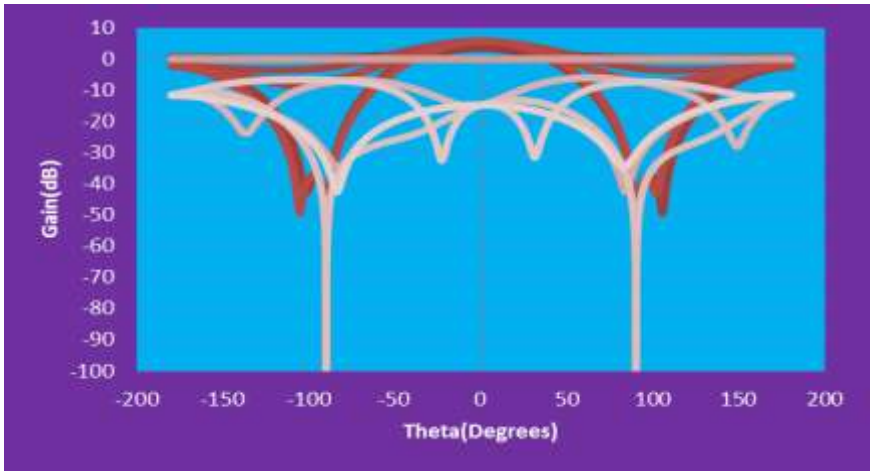

Fig. 6: *Gain Pattern of Proposed Antenna at 2.476 GHz.*

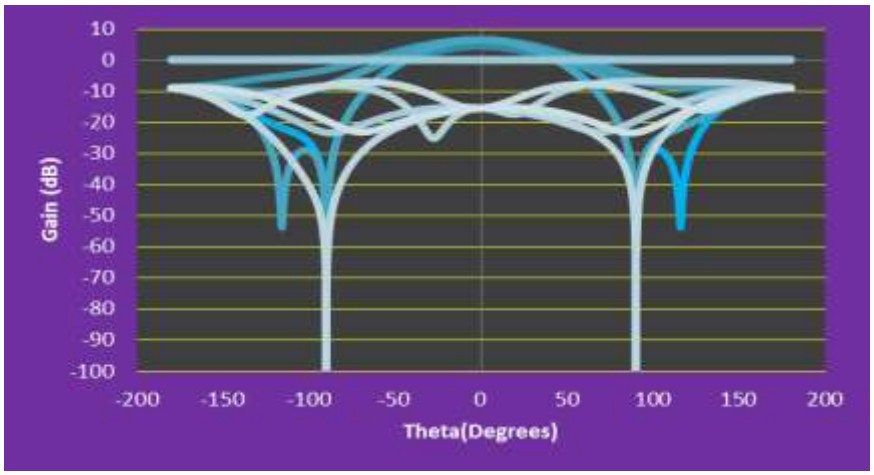

Fig. 7: *Gain of Proposed Antenna at 2.54 GHz.*

The gain of the proposed antenna are 4.5, 5.09 dB at the two resonant frequencies. The gain patterns are shown in Figures 6 and 7. The directivity, VSWR is found to be 4.6, 1.02 at first band while at second band it is 5.3, 1.49. The simulated antenna parameters are shown in Tables 3 and 4.

DISCUSSION

By etching two U shaped slots on conventional patch, one slot on feed, the patch is conveniently modified to suite the chosen wireless application. Further, the radiating feature is enhanced by means of etch on the ground. The proposed model has miniaturized up to 27 % of conventional patch size. The surface current density plots for conventional patch as well as for the proposed patch are shown in Figures 8–10.

Table 3: *Parameters of Proposed Antenna at 2.476 GHz.*

Antenna Parameter	Value	Unit
Max U	0.3035	W/sr
Gain	4.528	dB
Radiation Efficiency	98.056%	
Directivity	4.6146	
VSWR	1.0278	

Table 4: *Parameters of Proposed Antenna at 2.54 GHz.*

Antenna Parameter	Value	Unit
Max U	0.36653	W/sr
Gain	5.0927	dB
Radiation Efficiency	94.449%	
Directivity	5.392	
VSWR	1.4908	

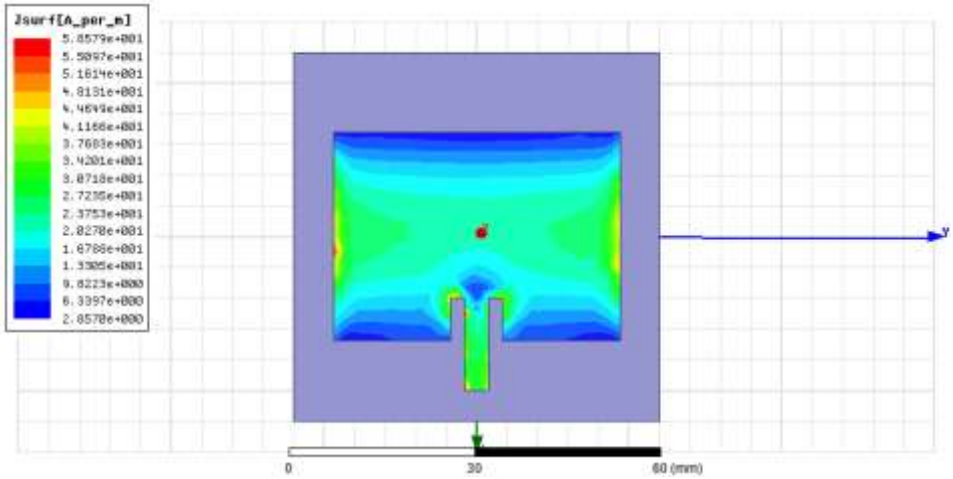

Fig. 8: *Surface Current Density Plot of Conventional Patch.*

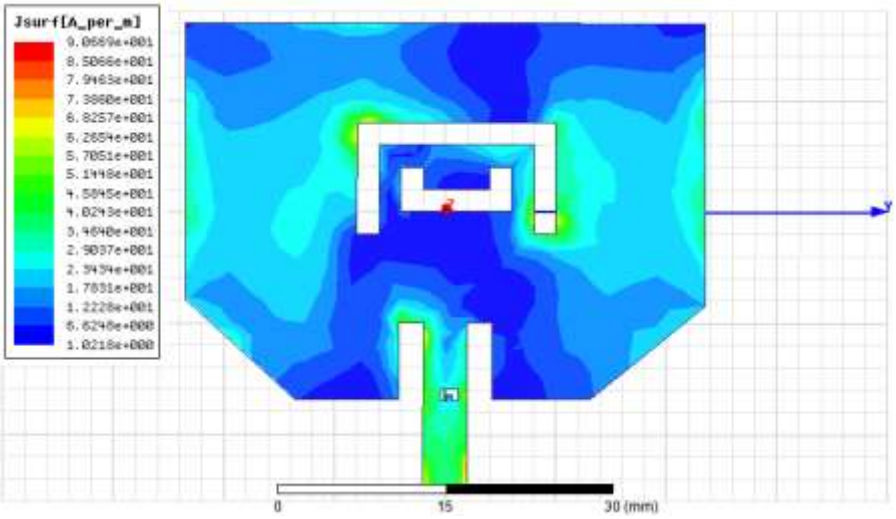

Fig. 9: *Surface Current Density Plot of Proposed Antenna at 2.476 GHz.*

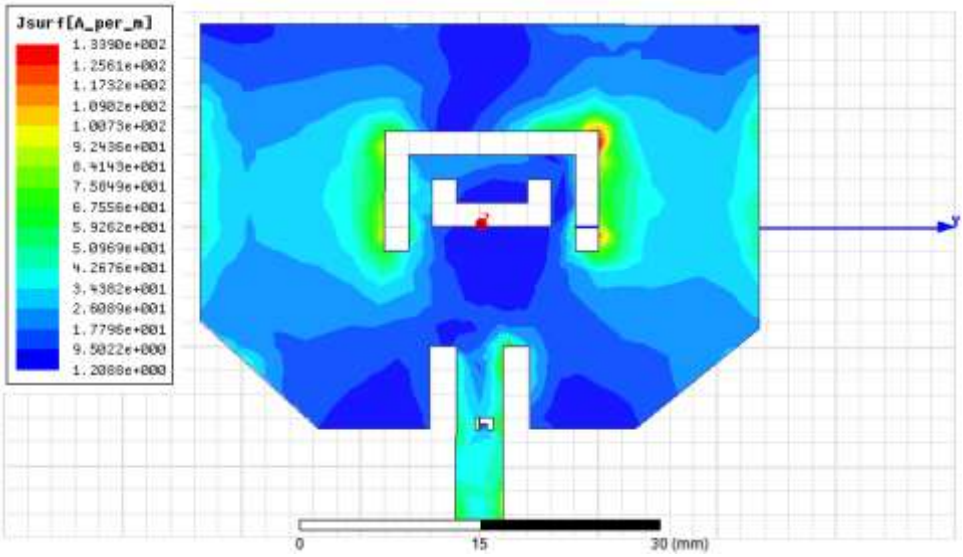

Fig. 10: *Surface Current Density Plot of Proposed Antenna at 2.54 GHz.*

CONCLUSION

The Proposed patch antenna resonates at WLAN, WIMAX frequency with a bandwidth of 24, 58 MHz. The return loss is found to be improved by -20 dB in the first band while -1 dB compromise is seen in the second band (when compared with conventional patch antenna). The antenna has adequate gain and an omnidirectional pattern. Cross and Co polarization levels (difference) varies between -10 dB to -15 dB. The radiating efficiency is nearly 95% in both the resonant bands. Thus, the proposal is an excellent candidate for the chosen application and can be easily realized using Photolithographic technique.

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