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Slotted Rectangular Microstrip Patch Antenna for WiMax applications

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Abstract. In this paper a compact Rectangular Micro-strip Patch Antenna (RMPA) with single feed is presented. Resonant frequency of proposed antenna is shifted toward lower side by introducing rectangular slot at the upper edge of patch. FR4 substrate having with thickness 1.6 mm is used as substrate material for the design of proposed antenna Performance of antenna in terms of Gain bandwidth is improved by adding a small piece of rectangular patch within the area of the rectangular slot. Antenna size has been reduced 48.9% when compared to conventional RMPA. The return loss of antenna of the antenna at resonant frequencies 3.3 GHz, 4.7 GHz and 6.7 GHz are -15.68dB,-17.71 dB and -33.82 respectively. Conventional square micro strip patch antenna gives return loss -10.91 dB at 7.4 GHz frequency. Ansoft HFSS V13.0.0 (high frequency structure simulator) software is used to investigate the characteristics of this antenna.

Keywords:microstrip, gain, returns loss, High Frequency Structure Simulator, VSWR.

1. Introduction

Rectangular Microstrip Patch Antennas (RMPAs) are mainly used for multiband applications as well as many broadband applications. The geometry of RMPAs based on fractal is an interesting topic for researchers in these days [1]. In last few years demand of small antennas in all applications has increased the interest on design of compact microstrip antenna among wireless engineers [2-3]. Special advantage of slotted antenna due to it have simple structure, bandwidth wider, low conduction loss and improved isolation between feed and radiating element [4]As day by day the demand of wireless systems and wireless devices is increasing the interest of researches in MPAs also increasing. These antennas of these types are popular for low profile applications at frequency above 100 MHz [5]. This microstrip antenna now a day is one of the most usable applications. More than one operating frequency of antenna for wireless communication also required for many applications.This is due to many reasons, mainly because there are various wireless devices and many telecommunication operators using various frequencies. Therefore antenna that has multiband characteristic is more desirable than antenna having one for each frequency band [6]. Size of the antenna can be reduced by cutting a slot in proper position of the patch. In this paper a compact microstrip antenna design obtained by cutting a rectangular slot on the rectangular patch and here is also addition of rectangular patch is developed within the area of rectangular slot to increase the return loss and gain-bandwidth performance of the antenna. To reduce the size of the antenna substrates are chosen with higher value of dielectric constant [7-8].The proposed antenna(substrate with ε_r= 4.4) has a gain of 4.074 dB and return loss of -33 dB when compared to a conventional square microstrippatch with a maximum bandwidth of 100 MHz The simulation has been carried out by HFSS [9] software. Due to the Small size, low cost and low weight this antenna is a good source for the application of wireless communication devices.

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2. Design of Antenna

Design of proposed antenna starts with a square patch having dimensions 20mm x20mm as shown in Figure1(a). The dielectric material selected for this design is an FR4 epoxy with dielectric constant (ε_r) = 4.4 and substrate height (h) = 1.6 mm. Co-axial probe feed of radius 0.5mm is used at point (16.5, 18.5). Then a rectangular slot with dimensions '*a*' and '*b*' as shown in Table-1 is introduced at the upper edge of patch. A small rectangular patch is with dimension '*c*' and '*d*' as shown in Table -1 is added within the area of rectangularslot which is placed distance apart from the side of the triangular slot. Geometry of proposed antenna thus obtained is shown in figure 1(b). Coaxial probe-feed with radius = 0.5mm is used as a feed for feeding the proposed antenna.

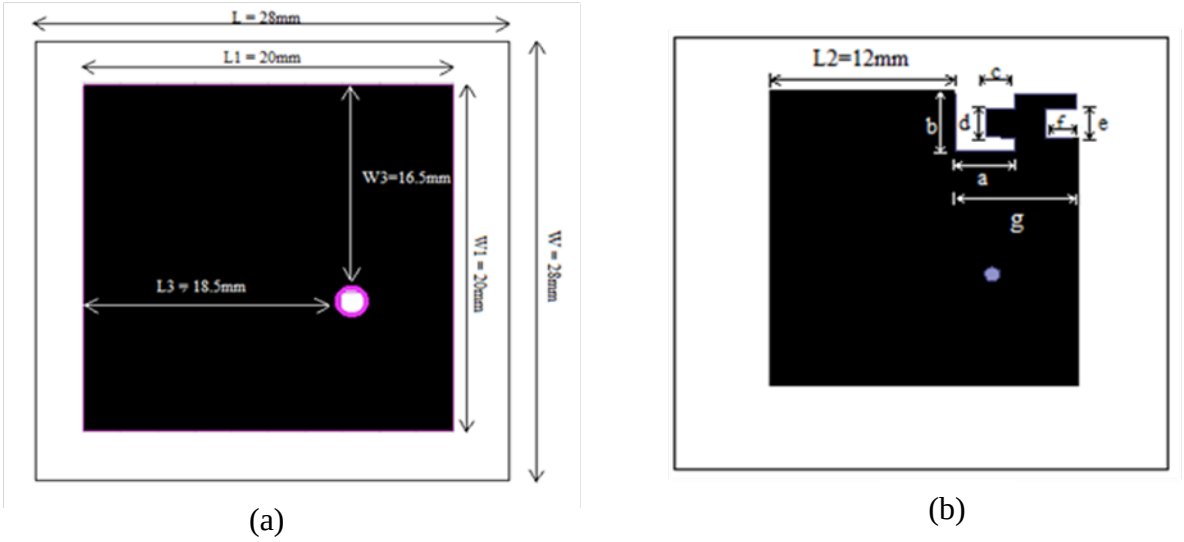

Fig.1(a) Layout of conventional RMPA **(b)** Layout of proposed antenna

Table 1. Dimensions of rectangular slot of proposed antenna

Sr. No	Parameters	Values in (mm)
1	a	4
2	b	4
3	c	2
4	d	2
5	e	2
6	f	2
7	g	8

3. Results and Discussions

In this antenna various parameters are calculated which are return loss, gain in dB, VSWR and radiation pattern. The comparison of simulated return loss of the conventional antenna and the proposed antenna are shown in Figure 2. From this figure it is clear that conventional antenna has return loss of -10.91dB and -15 dB at two frequencies 7.6 GHz and 8.5 GHz respectively.

Table 2. Comparison of results of proposed antenna with conventional antenna and Chakraborty antenna

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Parameters	Conventional antenna	Chakraborty antenna[3]	Proposed antenna
Resonant freq.(GHz)	7.6 , 8.5	3.34, 4.93, 7.48	3.34, 4.7, 6.7
Corresponding Return Losses (dB)	-10.9, -15	-27.3,-26.9, -20.2	-16, -18, -33.8
Reduction in Size	N/A	46.2 %	48.4 %

Proposed antenna have return loss of -16 dB,-18 dB and -33.8 dB at 3.3 GHz, 4.7 GHz and 6.7 GHz frequency respectively which shows that one more frequency 3.3 GHz gets add to this antenna. So here is a shift of frequency to lower side which reduces size of antenna by 48.4 % from conventional antenna. Also the return losses of proposed antenna are less than conventional antenna. Comparison of results of proposed antenna with conventional & antenna present in literature are also shown in table 2.From this table it is clear that percentage decrease in size of proposed antenna is more than conventional antenna and Chakraborty.VSWR versus frequency plot of proposed antenna is shown in figure 3. From this figure it is clear that VSWR is less than 2 at resonant frequencies 3.3 GHz, 4.7 GHz, and 6.7 GHzwhich is the required condition.The radiation patterns of the proposed antenna at resonant frequencies for phi equals to 0 degree and phi equals to 90 degree are shown in figure 4.

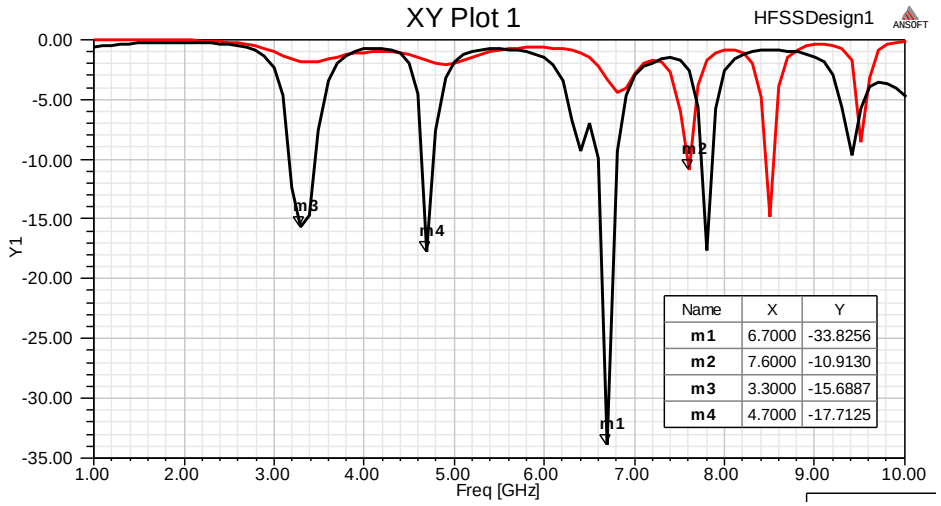

Fig. 2. Comparison of return loss of proposed antenna with conventional antenna

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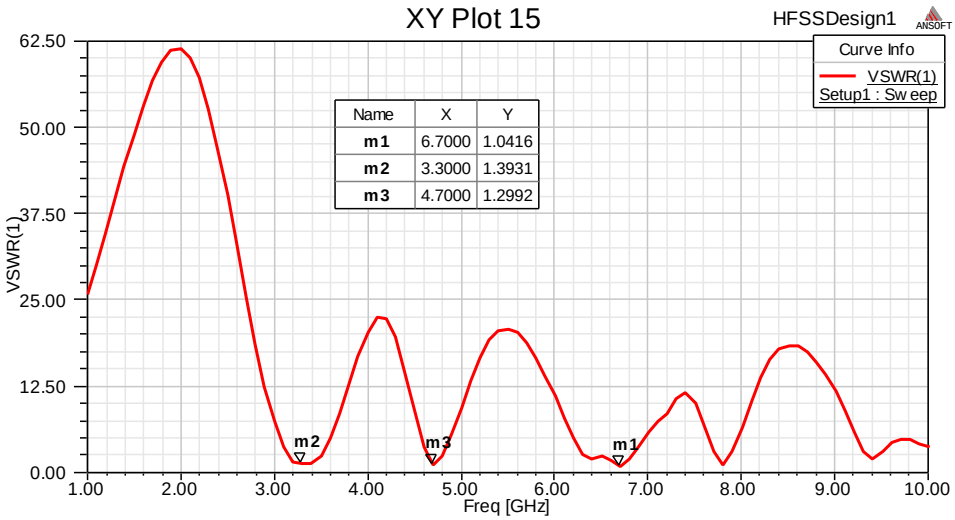

Fig. 3. Plot of VSWR versus frequency of proposed antenna

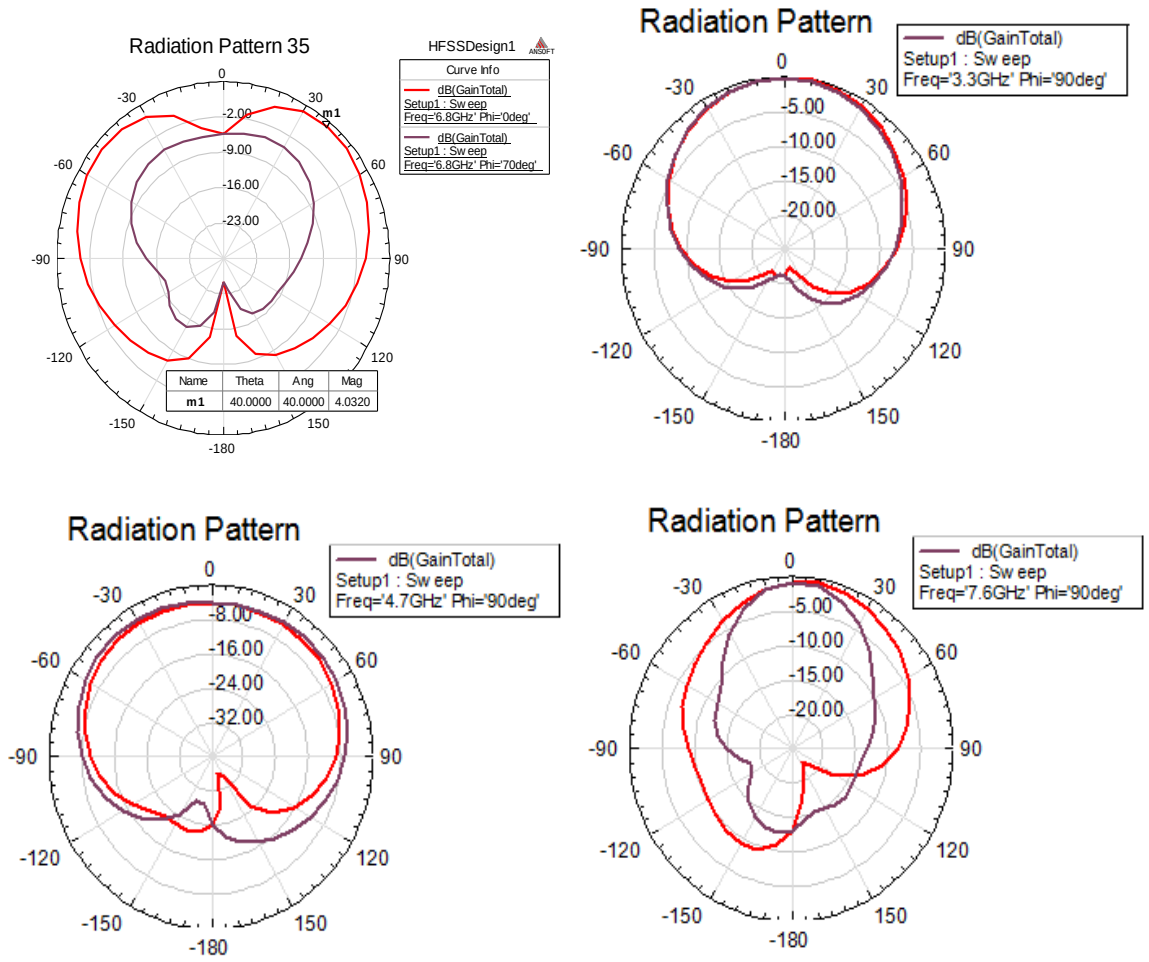

Fig.4. - Radiation Pattern of proposed antenna at (a) 6.7 GHz (b) 3.3 GHz (c) 4.7 GHz (d) 7.6 GHz

4. Conclusion

A single feed single layer rectangular slot microstrip antenna has been proposed in this paper. Rectangular slot reduced the size of the antenna and addition of a small rectangular patch within the area of the rectangular slot increase the bandwidth and return loss of -33.8 dB at 6.7GHz, -15.68dB at 3.3 GHz and -17.71 at 4.7 GHz frequency is obtained and absolute gain about 4.03 dB and 3 dB and VSWR of 1.04 is obtained in this paper.

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