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Rectangular Patch Antenna with Symmetric Slot for WLAN Applications

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Abstract- In this paper, microstrip patch antenna is designed for WLAN Applications. Rectangular microstrip patch antenna is designed, modified and simulated by a full wave simulator (IE3D). A rectangle of length 12.5mm and width 16.5mm with symmetric slot and tapering is simulated. The ground on which this proposed design is fabricated has relative permittivity (ε_r) of 4.4 with the thickness of 1.6mm. This design has 5.5 GHz resonance frequency and -47.2956dB is the achieved return loss. In this antenna design the feeding used is coaxial feeding. Many other parameters such as return loss, smith chart, directivity, gain are also described and discussed. The proposed antenna design finds the applications in WLAN especially in WIMAX devices.

Keywords – Microstrip patch antenna (MPA), Rectangular microstrip patch antenna (RMPA), Tapers, Bevels and WLAN Applications.

I. INTRODUCTION

A rectangular microstrip patch antenna design is proposed in this paper which is simulated in Full wave Simulator (IE3D). The proposed antenna achieves high return loss of -47.2956dB and gain of 4.13. The bandwidth achieved in this simulation is 304 MHz and it is very sufficient and suitable for WIMAX devices which are operating at 5.5 GHz. Microstrip patch antenna (MPA) are heavily used in application of microwave from last many years because of some advantages like ease in fabrication, high gain, simple and ease structure, light in weight, low in volume, good return loss, low in cost and robust [1] [2]. The main disadvantage is its bandwidth which is very narrow which causes the restriction of their many applications [1] [2] [3]. 6 is very good gain for any type of typical Microstrip patch antenna [3]. The antennas which have high performance are very useful and important in any type of applications which are related to wireless as transceiver. Few observations and experiments are done for improving the performance antenna with the help of slots, tapers and bevels [4]. With the different types of shapes of radiating patches like circular, rectangle, square, triangle, ellipse etc., and the rectangular radiating patch have good radiating property, ease to design small and compact in size as compared to other microstrip patch antenna shapes [2] [4]. Rectangular Microstrip patch antennas are widely used microstrip antennas, in many types of highly demanding applications the MPA are used [5]. This RMPA covers application which lies in the WLAN band frequency range but this proposed design is specifically for WIMAX devices.
Some rectangular patch antenna designs are presented in this paper which are single element and which are simulated in Full wave Simulator (IE3D). This paper consists of (1) Single element Rectangular Patch design, (2) Co-axial feeding, (3) Symmetrical slotting, (4) Tapering, (5) bevels at upper corners. The antenna which is proposed in this paper achieves high gain and more improved return loss. Its bandwidth after simulation is 304 MHz and this antenna is very suitable for WIMAX devices which work on 5.5 GHz.
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II. ANTENNA DESIGN

RMPA with symmetric slots is design, the dielectric constant of the ground plate on which RMPA is designed of 4.4. The proposed RMPA have length of 12.5mm and width of 16.5mm. In this design coaxial feeding is used at point (5, 7) of triangular shape having radius 0.08mm which is placed at substrate. In this RMPA, there are some symmetric slots which increase its return loss. In this paper, WLAN rectangular MPA is a single band antenna in 5-6 GHz band frequency. A rectangle patch of length 12.5mm and width 16.5mm is designed. Symmetrical two slots are cut at various coordinates which have the length of 0.5mm and width of 1mm. There are two symmetrical tapers of length 5mm and width 1mm are cut at the sides of the patch. Two symmetrical tapers are also cut at the upper part of the patch of length 7mm and width 2.2mm. There are also two bevels cut at the upper part of the patch having length and width of 1.5mm and 1.5mm each, at an angle of 45^0 each. The proposed antenna design with symmetric slots is designed on IE3D is shown in the fig. 3**.** The dimensions of lengths and widths of the RMPA are shown in tabulated form in Table 1.

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Table 1 Dimensions of RMPA

Component	**Length (mm)**	**Width (mm)**
Patch	12.5	16.5
Feed Point (co- ordinates)	5	7
Slots	0.5	1
Upper Tapers	7	2.2
Side Tapers	5	1
Bevels at upper corners	1.5	1.5

A. Single Element:

In proposed design, at point (0, 0, 1.6) the ground is made having dielectric constant (€r) of 4.4, loss tangent for €r is 0.01 with relative permeability (μ_r) of 1. A rectangular patch is design at (0, 0) with length of 12.5mm and width of 16.5mm. Co axial feeding of triangular shape is done at (5, 7) of radius 0.08mm.

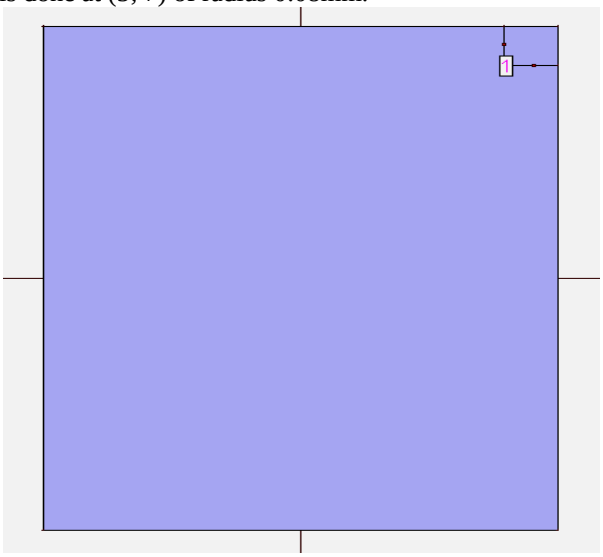
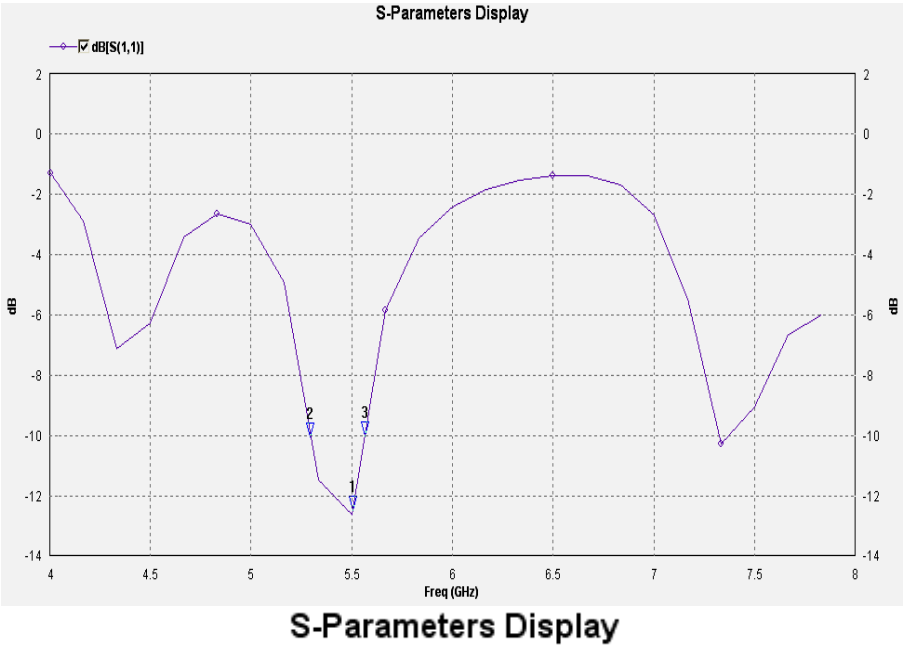


Fig. 1 Single element RMPA



S-Parameters Display

Fig. 2 Simulated Return loss of single element RMPA

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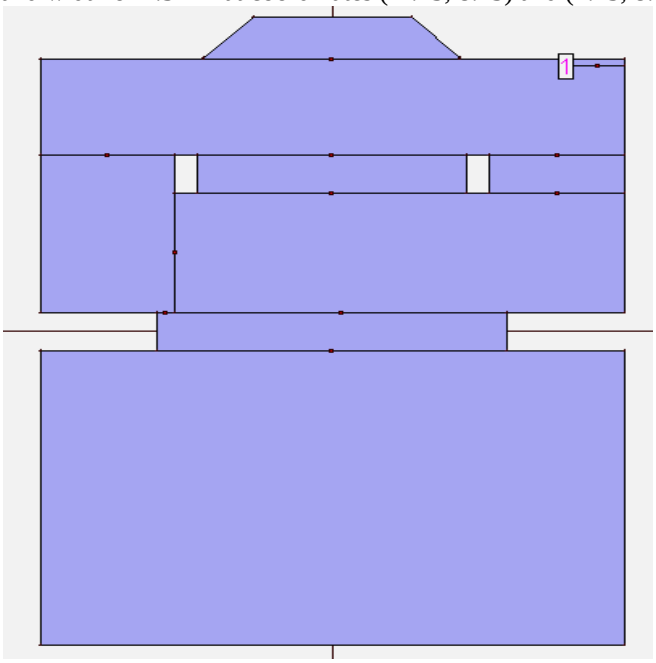
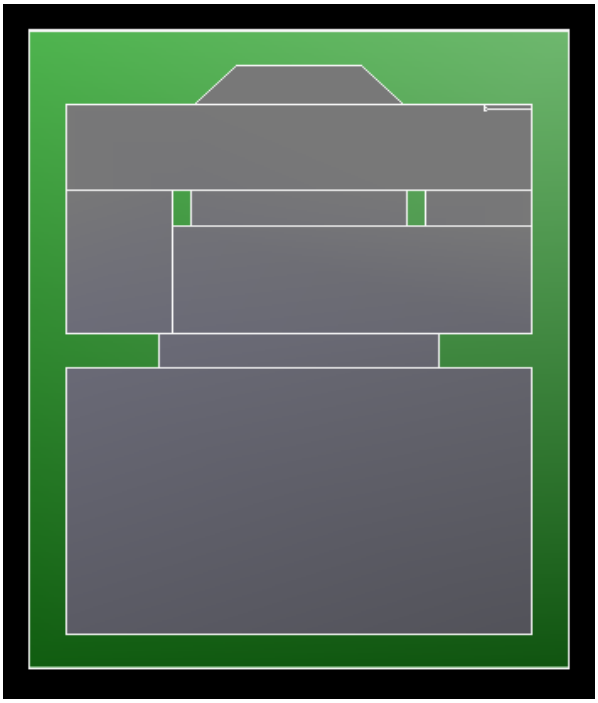
Two symmetrical slots of length 0.5mm and width 1mm is done at coordinates (-3.125, 4.125) and (3.125, 4.125) respectively. Another two symmetrical tapers which are cut at upper part of patch of length 7mm and width 2.2mm is done at coordinates (-6.25, 8.25) and (6.25, 8.25), two symmetrical tapers are also cut at the sides of the patch of length 5mm and width 1mm at the coordinates (-6.25, 0) and (6.25, 0), there are also two symmetrical bevels cut at the upper part of patch of length 1.5mm and width of 1.5mm at coordinates (-2.75, 8.25) and (2.75, 8.25).



(a) Front View of proposed RMPA



(b) 3D geometric view

Fig. 3 Structure of the RMPA with symmetric slots and tapering [showing in (a) and (b)].

III. SIMULATION AND EXPERIMENTAL RESULTS

The RMPA with symmetric slots and tapering is simulated using IE3D Software. The simulated return loss of proposed antenna from 4 to 8 GHz band using a 50Ω SMA (Sub Miniature version A) connector at port 1 which is shows in figure 4. The simulated return loss in proposed RMPA is -47.2956dB at a centre frequency of 5.5 GHz which having lower frequency (f_L) of 5.347 GHz and higher frequency (f_H) of 5.651 GHz. The bandwidth obtain by this proposed antenna is 304 MHz shown in fig. 4, Smith chart is shown in fig. 5, the VSWR graph is shown in figure 6, the maximum gain at centre frequency is 4.13 is shown in fig. 7.

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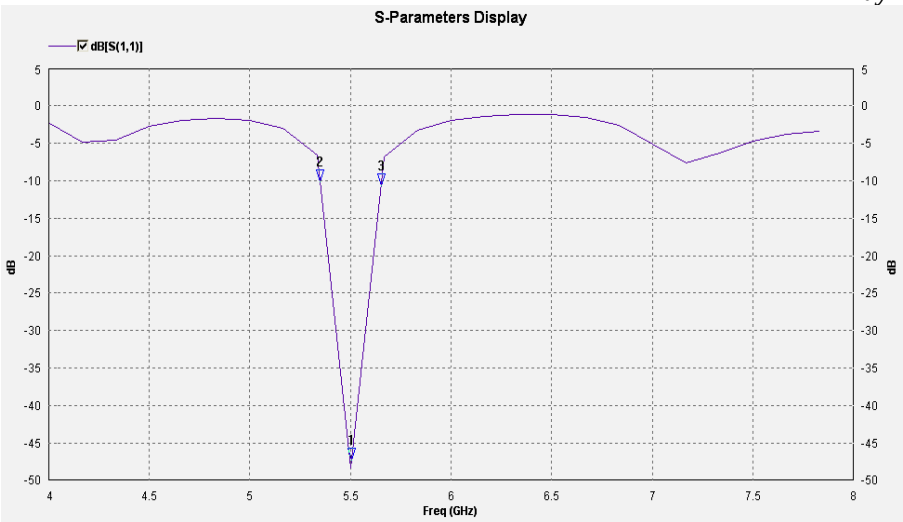

S-Parameters Display

Fig. 4 Simulated result of the proposed RMPA

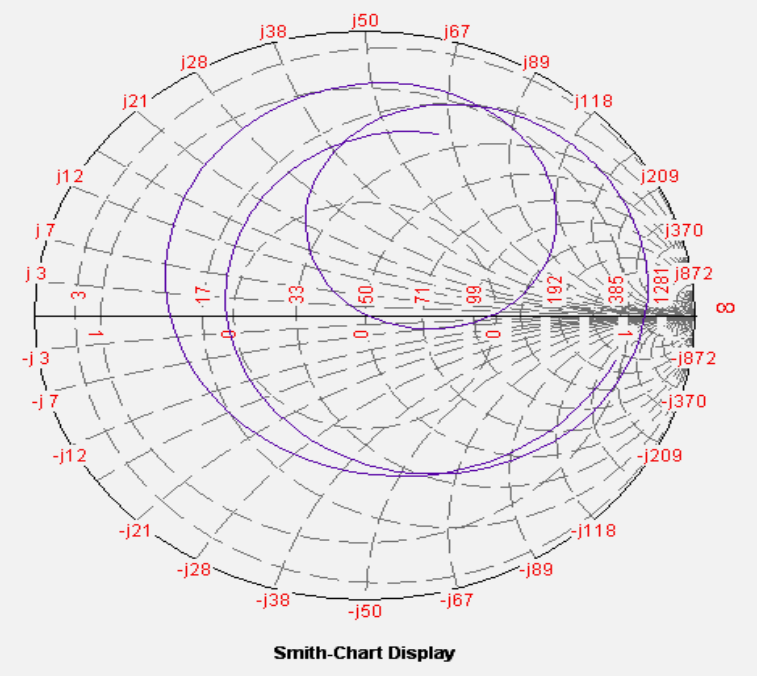

Fig. 5 Simulated Smith Chart result of the proposed RMPA

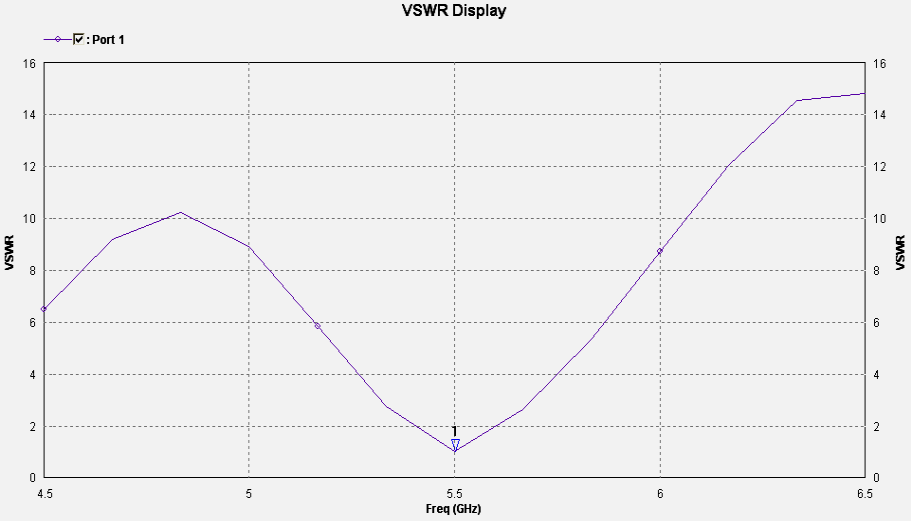

Fig. 6 Simulated VSWR result of the proposed RMPA

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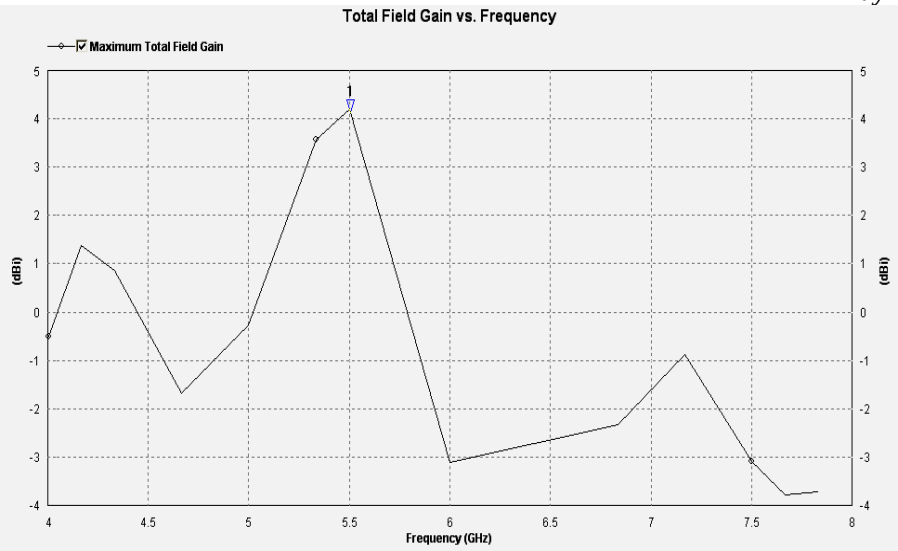

Fig. 7 Simulated gain vs. Frequency result of the proposed RMPA

IV. CONCLUSION

In this paper, rectangular microstrip patch antenna is studied. The shape of patch is taken as Rectangle. The shape and design of the proposed antenna are compatible with WLAN applications. The design is specifically for WIMAX application devices which operate at 5.5GHz frequency. In result, the gain is improved because of the slotting and tapering process. In this paper, symmetrical slots and tapering are used in the rectangular microstrip patch antenna which gives improvement in return loss with the given coordinates for symmetrical slots. In the final design, the resulting parameters are successfully improved. This proposed RMPA is designed for wireless communication in WLAN specifically for the WIMAX application devices.

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