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Broadband Slotted Rectangular Shaped Microstrip Antenna For WI-Max Applications

[1]Chandan Kumar Dubey, [2]Sumit Tahlani, [3]Paresh Singh Rajoriya
[1]*(Asst. Prof., Department Of Electronics & Communication Engineering, Poornima Group Of Institutions, Jaipur, India)*
[2]*(B.Tech., VIII Sem., Department Of Electronics And Communication Engineering, Poornima Group Of Institutions, Jaipur, India)*
[3]*(B.Tech., VIII Sem., Department Of Electronics And Communication Engineering, Poornima Group Of Institutions, Jaipur, India)*

ABSTRACT
Many applications require very broadband antenna, but the narrow bandwidth of a microstrip antenna restricts its wide usage. The aim of this paper is to enhance the bandwidth of rectangular microstrip patch antenna. For this purpose, we cut four slots in the proposed antenna. The dielectric substrate material of the antenna is glass epoxy FR4 having ε_r=4. 4 and loss tangent 0.025. The performance of the final modified antenna is compared with that of a conventional rectangular microstrip antenna. The designed antenna has two resonant frequencies 5.42 GHz and 5.70 GHz. So this antenna is best suitable for the Wi-Max applications. The designed antenna offers much improved impedance bandwidth 10.45 %. This is approximately two times higher than that in a conventional rectangular patch antenna (Bandwidth= 5.34%) having the same dimensions.
Keywords– Broadband, FR4 substrate, Parallel slots, Gain, Resonant frequency

I. INTRODUCTION

In the recent years, there has been rapid growth in wireless communication. Day by day users are increasing, but limited bandwidth is available and operators are trying hard to optimize their network for larger capacity and improved quality coverage. This surge has led the field of antenna engineering to accomadte the need for broadband, low cost miniaturized and easily integrated antennas[1]. A widely used antenna structure with above characteristics is microstrip patch antenna. Microstrip patch antennas consist of a very thin metallic strip (patch) on a grounded substrate found extensive applications in wireless communication systems owing to their advantages such as low profile, conformability, low fabrication cost and ease of integration with feed network. Microstrip patch antennas come with a drawback of narrow bandwidth, but wireless communication applications require broad bandwidth and relatively high gain [2-3]. The shape of antenna varies according to their use, the work is continuously getting occurred to achieve faithful factors, by small size antenna for broadband communication [4-6]. Several techniques have been used to enhance the bandwidth by interpolating surface modification in patch configuration [7].

In past decades of communication world , microstrip antennas have played an active role and have become a major research topic due to their advantages and ease in fabrication and integration with solid state devices[8-9]. To increase the bandwidth of the proposed microstrip patch antenna four square shape slots have been introduced in the antenna geometry.

II. ANTENNA DESIGN

We considered a single layer conventional microstrip patch antenna. Dimension for this conventional patch were taken as Length L=40 mm and Width W= 64 mm. FR4 substrate is used to design this conventional patch by us. The dielectric constant of FR4 is 4.4, loss tangent is 0.025 and The thicknessof FR4 substrate is 1.6mm. The coaxial probe feed technique was used to excite the patch. Design and simulation process were carried out using IE3D simulation software 2007 version 12.30.

The geometry of the conventional rectangular microstrip patch antenna is depicted in figure 1.

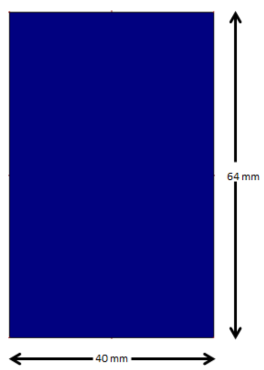

Figure 1: Geometry of Conventional Rectangular Patch Microstrip Antenna

III. RESULTS

The conventional rectangular patch antenna is simulated first using IE3D software. This simulated reflection coefficient curve shows that our conventional rectangular patch antenna is resonating at frequency 5.35 GHz and 5.48 GHz as shown in figure 2. The value of impedance bandwidth of conventional rectangular microstrip patch antenna is 5.34%. Since the rectangular patch antenna has low bandwidth, so to improve the performance of this antenna further modifications are required.

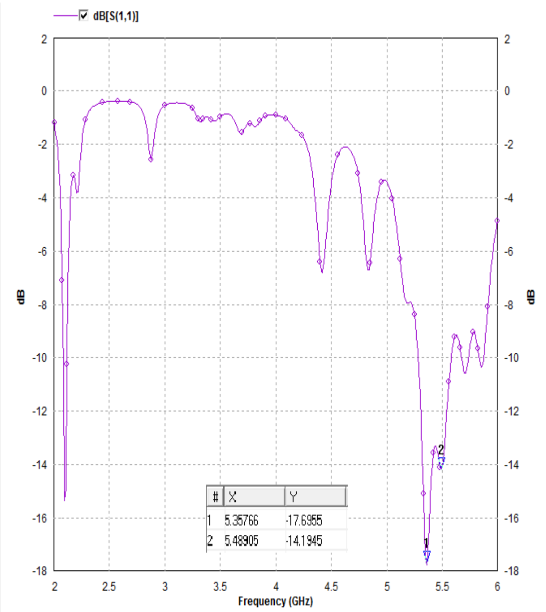

Figure 2: Variation of Reflection Coefficient v/s Resonant Frequencies

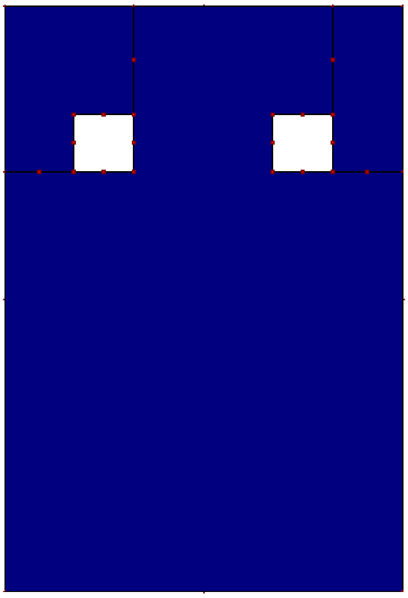

Figure 3: Structure of Rectangular Patch Microstrip Antenna with two square shape slots

So in order to increase the bandwidth we cut two square slots in antenna geometry as depicted in figure 3. The figure 4 shows the variation of reflection coefficient with frequency. It shows that the modified antenna is resonating at 5.45 GHz and 5.83 GHz frequencies. After modification in the conventional rectangular patch , this time we got the value of impedance bandwidth is 10.32 %. The simulated result shows that the input impedance at resonant frequencies 5.45 GHz and 5.83GHz are (46.3+ j4.06) ohm and (50.3-j1.14) ohm respectively which are very close to 50 ohm.

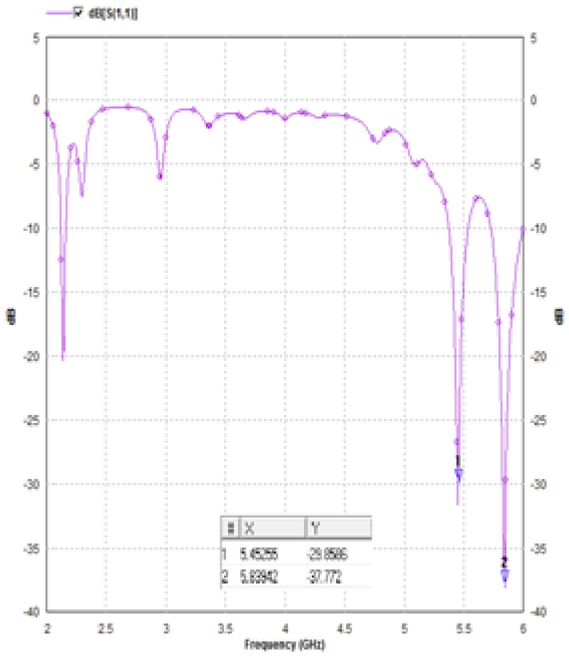

Figure 4: Variation of Reflection Coefficient v/s Resonance Frequency

Still, we have not received a precise bandwidth. In our next step of designing process, we cut two more square shape slot in the proposed antenna geometry to get wider bandwidth. The structure of final modified rectangular patch microstrip antenna is shown in figure 5.

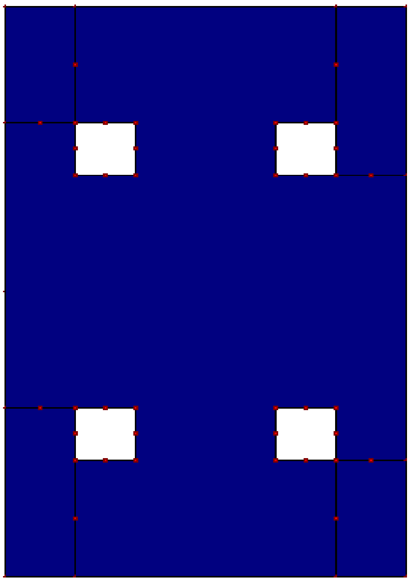

Figure 5: Structure of final modified rectangular patch microstrip antenna

The figure 6 shows the variation of reflection coefficient with resonant frequencies. It shows that after second modification the antenna is resonating at two resonant frequencies 5.42 GHz and 5.70 GHz. In this case we achieved the bandwidth of 10.45%

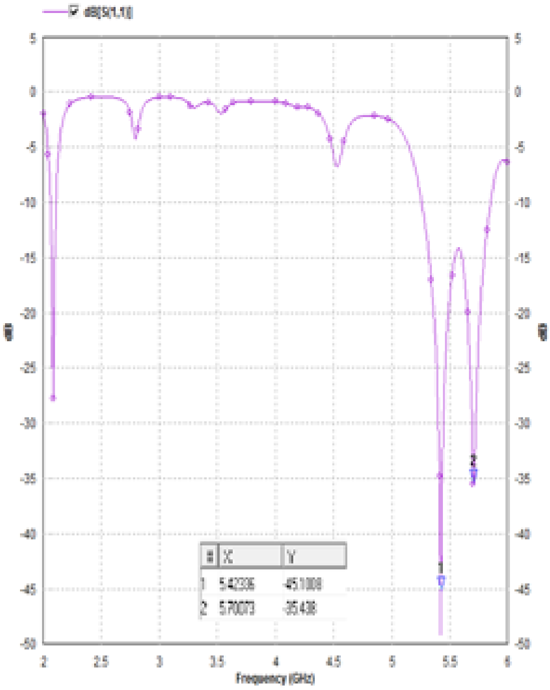

Figure 6: Variation of Reflection Coefficient v/s Resonance Frequencies

The smith chart for this modified antenna is shown in the figure 7. At the resonant frequencies 5.42 GHz, and 5.70 GHz the measured input impedances are (49.85 + j 0.40) ohm and (50.65 – j 1.4) ohm respectively.

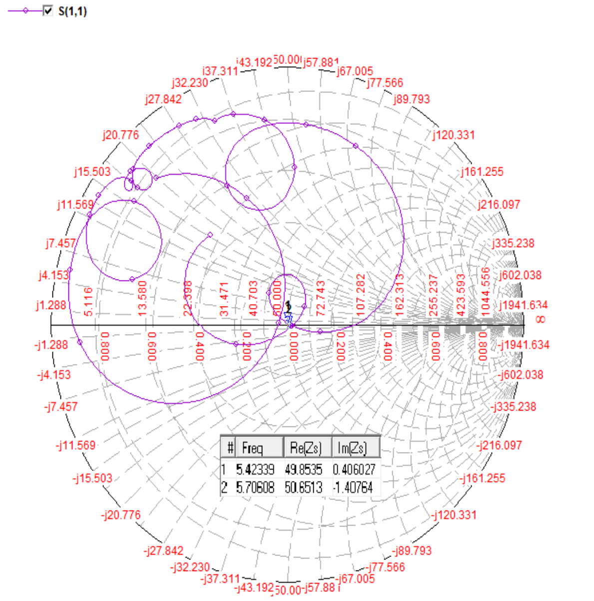

Figure 7: Smith chart of final modified rectangular patch microstrip antenna

The gain curve for this antenna is shown in figure 8. The simulated gain at frequencies 5.42 GHz and 5.70 GHz are 2.25 dBi and 0.56 dBi respectively. So finally we got broadband antenna.

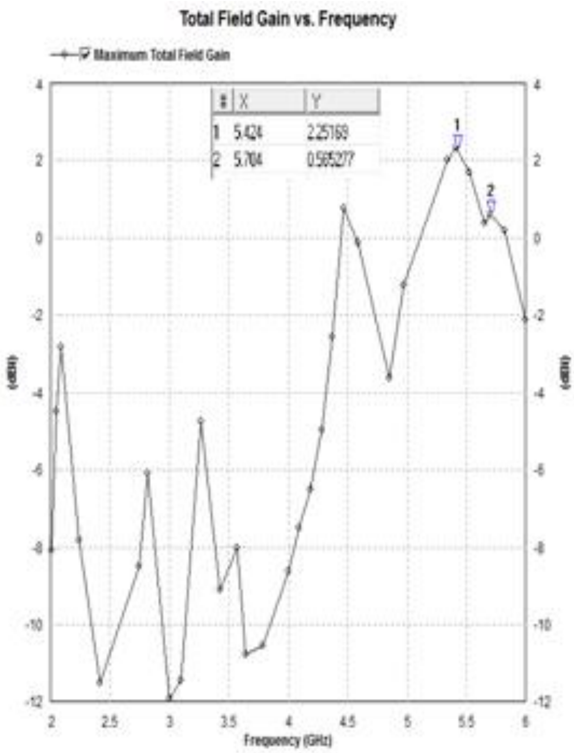

Figure 8: Variation of gain v/s resonance frequencies

The curve between directivity and resonant frequencies is shown in fig. 9. The directivity of this antenna is 9.58 dBi and 9.51 dBi for the resonant frequencies 5.42 GHz and 5.70 GHz respectively.

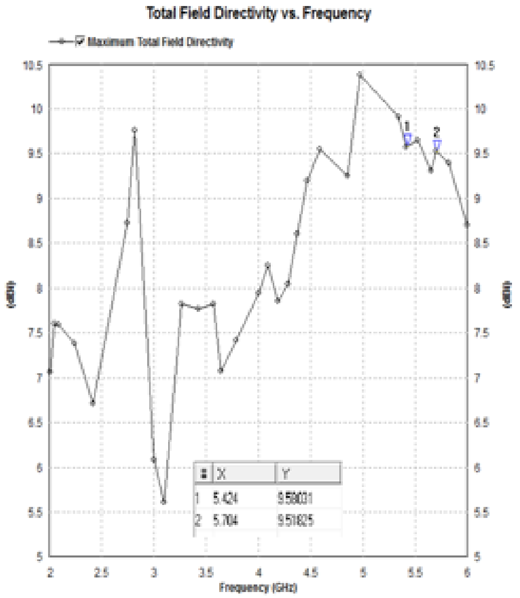

Figure 9: curve between directivity and resonant frequencies

The curve between radiation efficiency and resonant frequencies is shown in figure 10.

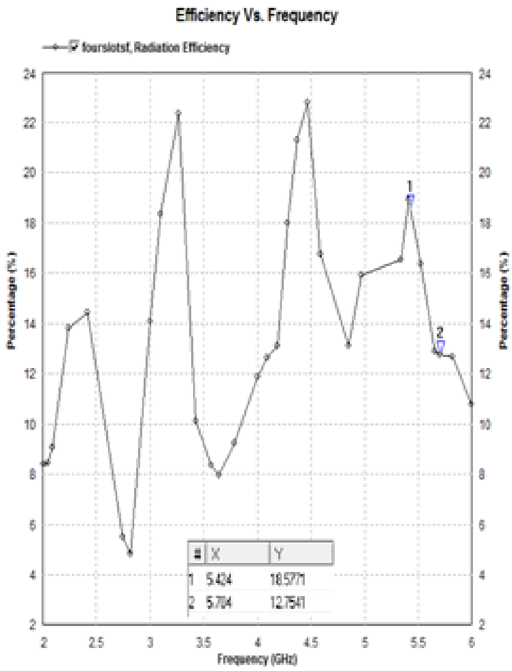

Figure 10: curve between radiation efficiency and resonant frequencies

The radiation efficiency of the antenna is 18.57 % at 5.42 GHz and 12.75 % at 5.70 GHz. The variation of VSWR with the resonance frequencies is shown in figure 11. The values of VSWR at resonance frequencies 5.42 GHz and 5.70 GHz are 1.01 and 1.03 respectively.

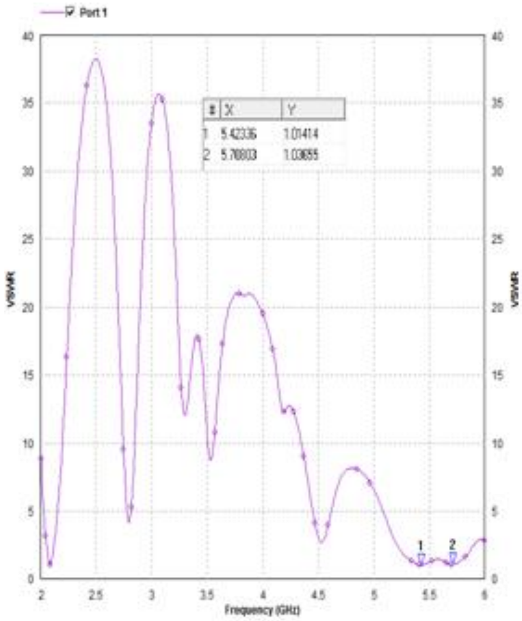

Figure 11: curve between VSWR and resonant frequencies

The radiation patterns at resonant frequencies 5.42 GHz and 5.702 GHz are shown in figure 12 and figure 13 respectively. At 5.42 GHz the direction of maximum radiation is normal to the patch geometry. At 5.70 GHz the direction of maximum radiation is shifted 30^{o} left and 60^{o} right side of the normal to the patch as represented in the following figures.

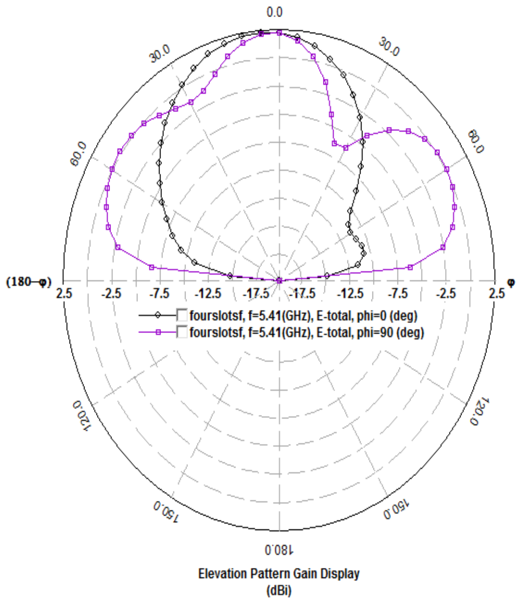

Figure 12: 2D polar Radiation pattern at 5.42 GHz

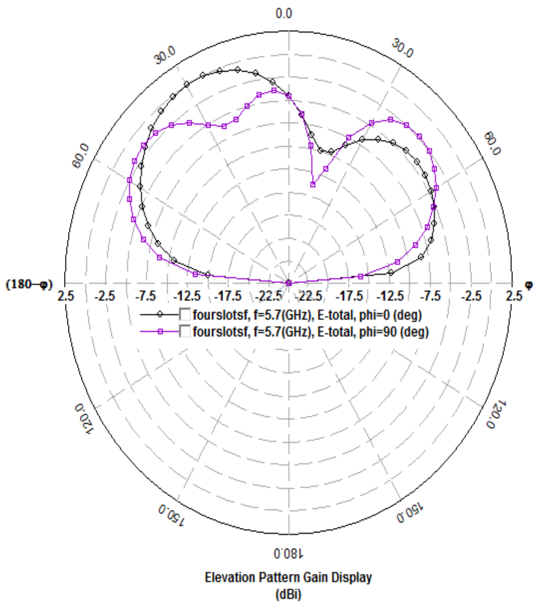

Figure 13: 2D polar Radiation pattern at 5.70 GHz

IV. CONCLUSION

The proposed Ractangular patch microstrip antenna with four square shape slots resonates at two frequencies 5.42 GHz and 5.70 GHz. By using this antenna we got much improved bandwidth of 10.45% in comparison with a conventional rectangular patch antenna having a bandwidth of 5.34%. The designed antenna exhibits a good impedance matching of about 50 ohm. From the analysis of simulated results it can be verified that the proposed antenna is best suitable for WI-Max applications.

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