Design of Multifrequency Broadband Electromagnetically Coupled Rhombus Shaped Microstrip Antenna for Wireless Communication System

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Abstract

The aim of this paper is to design a broadband Rhombus shaped microstrip antenna which is electromagnetically coupled. The single rhombus shaped microstrip patch antenna presented in this paper has been divided into five patches which are electromagnetically coupled. The radiating structure has a shape of rhombus type to reduce the overall dimensions. The designed antenna has three resonant frequencies 5.60 GHz, 5.80 GHz, 6.29 GHz The antenna is designed on FR4 substrate and characterized by measuring return loss, VSWR, gain bandwidth and radiation pattern. This antenna is designed and simulated using IE3D simulation software.

Keywords: *Bandwidth, Electromagnetically coupled, FR4 Substrate, Broadband*

1. Introduction

This paper work demonstrates the design and analysis of Rhombus shaped microstrip antenna. The designed microstrip patch antenna has broadband operation and provides better gain as compared to simple rectangular shaped patch antenna of the same dimensions. The serious problem with patch antenna is their narrow bandwidth due to surface wave losses and large size of patch. As a result, various techniques to enhance the bandwidth are proposed. We chosen rhombus shaped patch to reduce the overall dimensions. To increase the bandwidth the proposed patch antenna is divided into five patches and electromagnetically coupling is provided among them. In this arrangement the gap between each divided patch is 0.8 mm. The substrate used to design this antenna is FR4 substrate.

2. Antenna Design

At the beginning of designing process, first we considered a single layer conventional microstrip patch antenna. Dimension for this conventional patch were taken as 30mm x 45mm. FR4 substrate was used to design this conventional patch. The Z top for FR4 substrate is 1.6mm, loss tangent is 0.025 and dielectric constant is 4.4.Simple 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.

3. Results and Discussions

The geometry of the conventional rectangular microstrip patch antenna and corresponding resonant frequencies is depicted in fig.1.

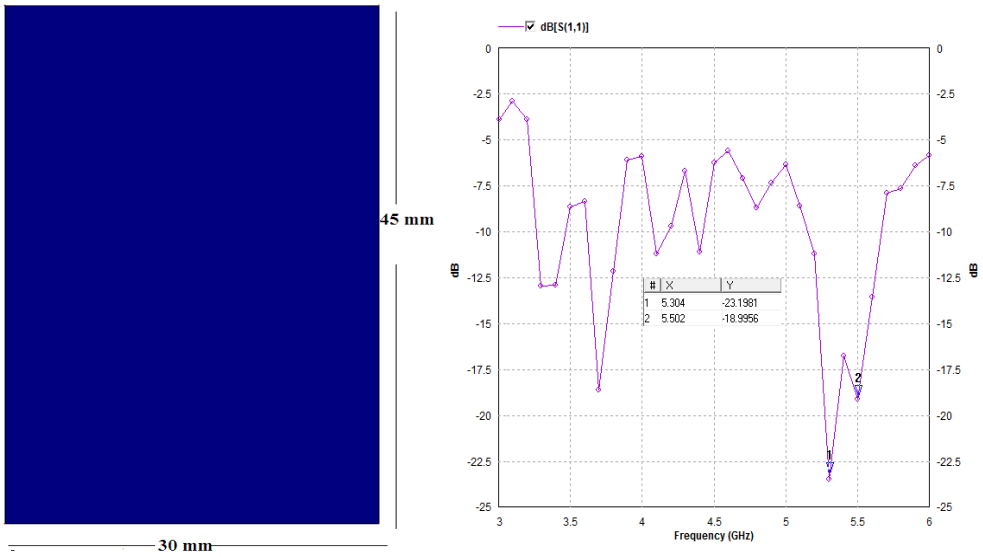

Fig. 1: Geometry of Conventional Rectangular Patch Microstrip Antenna and corresponding resonant frequencies

This antenna is resonating at frequency 5.304 GHz and 5.502 GHz as shown in fig. 1. The value of measured bandwidth of conventional rectangular microstrip patch antenna is 10.18%. Smith chart for rectangular microstrip patch antenna is depicted in fig. 2. The measured input impedance of antenna at first resonance frequency 5.304 GHz is close to 50 ohm impedance but little poor matching (47.41 + j 10.32) ohm at the second frequency 5.502 GHz is achieved.

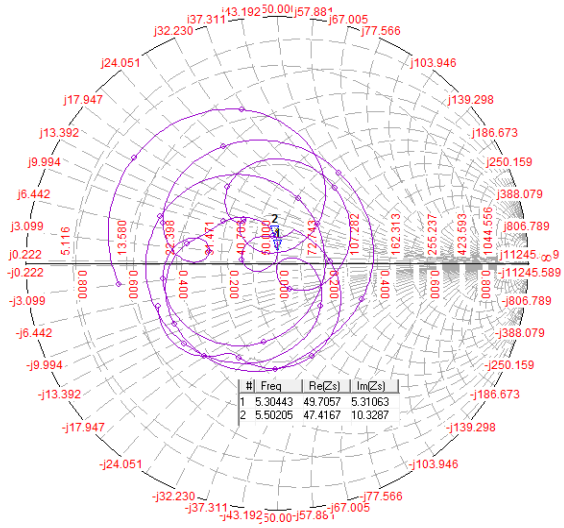

Fig. 2: Smith Chart for Conventional Rectangular Microstrip Patch Antenna

Since rectangular patch antenna has low bandwidth and little poor impedance matching, so to improve the performance of this antenna further modification is required. To improve the bandwidth and also reduce the total dimensions of rectangular patch antenna

we designed the Rhombus Shaped Patch Antenna (RSPA) with rectangular shape for the internal patch. The gap between each patch is 0.8 mm [1]. The geometry of modified antenna and corresponding resonant frequencies is depicted in fig. 3.

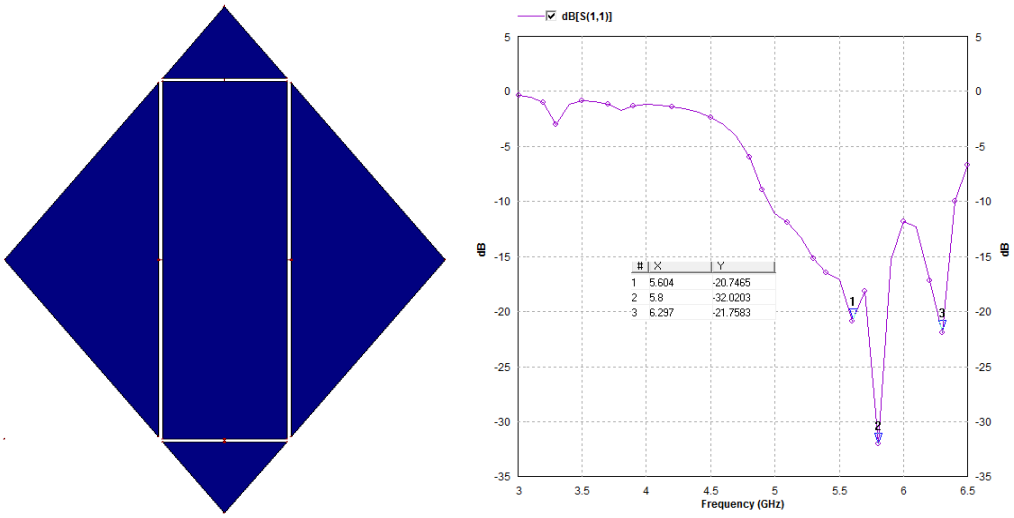

Fig 3: Structure of RSPA having rectangular shaped internal patch and corresponding resonant frequencies

It shows that the modified antenna is resonating at resonant frequencies 5.60 GHz, 5.80 GHz and 6.29 GHz. This time we achieved bandwidth of 26.25%. The smith chart for Modified antenna is shown in fig.4. Input impedance of the antenna is close to the 50 ohm as depicted in the following figure.

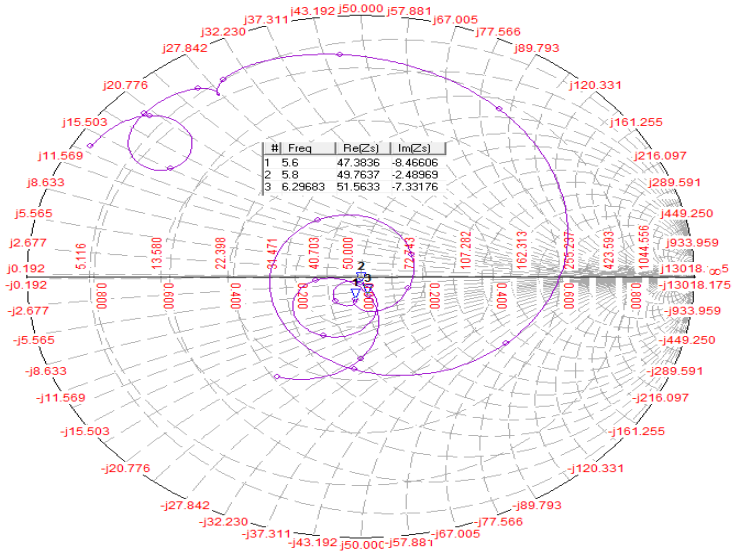

Fig. 4: Smith Chart for Modified RSPA having rectangle shaped internal patch

The gain curve for this modified antenna is shown in fig. 5. The measured gains at frequencies 5.60 GHz, 5.80 GHz and 6.29 GHz are 3.43 dBi, 4.49 dBi and 2.36 dBi respectively. So finally we got broadband antenna with good gain by using this geometry.

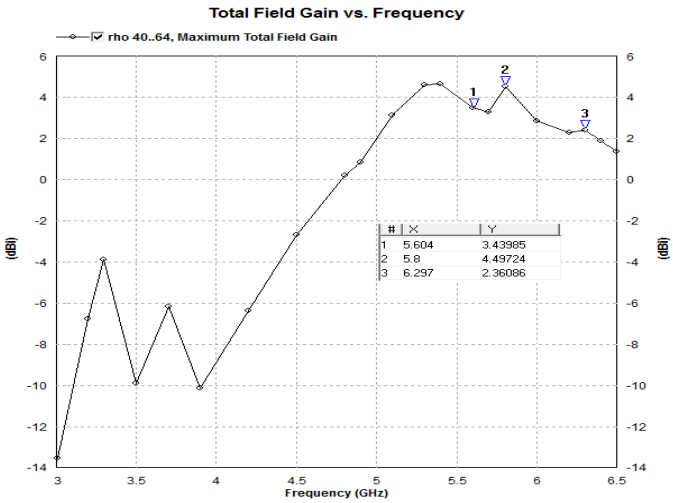

Fig. 5: Variation of gain v/s resonance frequency

4. Conclusion

The proposed Rhombus Shaped Patch Antenna having a central rectangular patch with 0.8 mm gap coupling resonates at three frequencies 5.60 GHz, 5.80 GHz and 6.29 GHz. for C band applications. The effect of gap coupling on the antenna performance is noticed. The designed antenna enhances the gain up to 4.49 dBi, this is quite well. Finally, we got much improved bandwidth of 26.25% in comparison with a conventional rectangular patch antenna having a bandwidth of 10.18%.

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