Rectangular Microstrip patch antenna Design having defected ground for WiFi applications

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Abstract- A single-feed rectangular microstrip patch antenna with defected ground and patch is investigated in this communication. The antenna is designed to function in the 3-6 GHz for GPS usage. The proposed antenna not only resonates efficiently at 6.048 GHz frequency but also offers improved bandwidth (31.22%) in comparison with a conventional rectangular microstrip antenna (≈ 4%) by optimizing the ground plane dimensions.

Index Terms- Microstrip patch antenna (MSA), Dual frequency, Magnetic field (H).

1. INTRODUCTION

Now days the modern communication systems requirement is to develop small size, lightweight, low profile, broad bandwidth, and proper polarization in the antenna design for the miniaturization of the communication equipments [1]. Microstrip antennas have many desirable features such as low profile, lightweight, and are usually fabricated by lithographic etching process or a mechanical milling process [8]. The antennas are largely found in mobile and satellite communication for its easy fabrication process and compactness which give easily fit in any surfaces [7]. Several techniques are used to improve the radiation characteristics of microstrip patch antenna and make it operational at two and more frequencies [3] [5].

In this communication, we propose a geometry consisting of single-layer rectangular microstrip patch antenna with improved performance than a conventional rectangular patch antenna operating under identical test conditions. The simulation studies are carried out by using IE3D simulation software [2] [6].

2. ANTENNA GEOMETRY

The geometry of the proposed frequency band microstrip patch antenna with finite ground plane is considered lying in the X–Y plane as shown in Figure 1. This antenna is designed on FR4 substrate having thickness h=1.59 mm, substrate dielectric constant ε_r= 4.4, substrate loss tangent $\tan\partial_s$= 0.025, and relative permeability=1.The patch dimensions are L= 20 mm and W= 20 mm. Antenna is fed through a simple coaxial probe.

The simulated resonance frequency corresponding to dominant mode (TM_{11} mode) of conventional rectangular patch antenna (without any ground reducing) designed on FR4 substrate having patch dimension L= 20 mm and W= 20 mm is 5.72 GHz. The impedance bandwidth of this antenna is 4.06%. The gain is close to -0.54 dB. This is not the requirement of modern communication system. But after introducing and reducing or defected the finite ground from L=30 mm. and W=30 mm to W=8 mm. and L=8 mm and introducing a slot from the ground reducing 388 mm^2 i.e, almost 50% of its area (L_x= 8mm, W_y= 8mm) the resonant frequency 6.048 GHz is obtained.

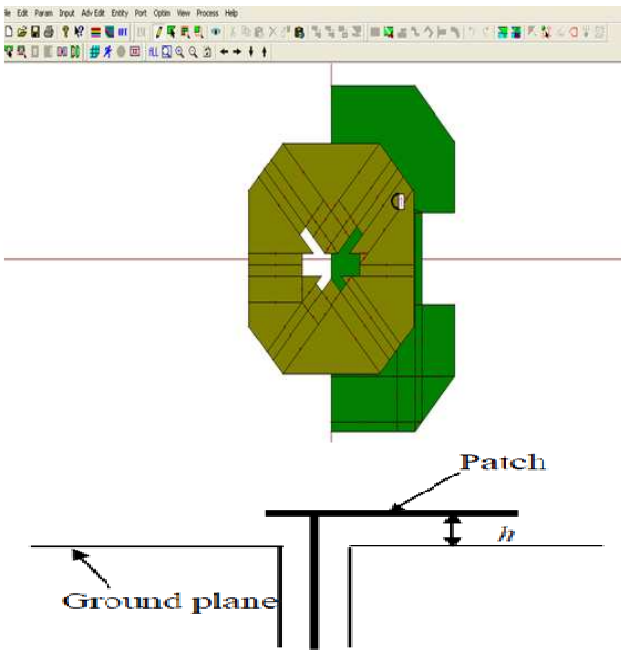

Figure 1: Antenna geometrical configuration

The design idea was taken from broadband antennas to make the antenna work in a large frequency band. In this work, co-axial or probe feed technique is used as its main advantage is that, the feed can be placed at any place in the patch to match with its input impedance (usually 50 ohm) [7]. The software, is used to make the geometrical model and simulate the rectangular microstrip patch antenna, Zeland IE3D V-12 [2] [6] can be used to calculate and plot return loss, VSWR, radiation pattern, smith chart and various other parameters.

3. RESULT AND DISCUSSION

The proposed antenna has been simulated using Zeland IE3D V-12 software [6]. Figure-2 shows the variation of return loss with frequency. Plot result Fig. 2(a) shows 6.048GHz frequency. Total available impedance band width is 31.22 % from the proposed geometry at -52.19 dB return loss for resonant frequencies. The design also provides 37.59% radiation efficiency and 37.59 % antenna efficiency and 1.56 dB gain. Figure 2(b) shows the input impedance loci using smith chart. Input impedance curve passing near to the 49.91+ 0.02j point impedance circle that shows the perfect matching of input. Figure 3 shows the Gain of the microstrip patch antenna.

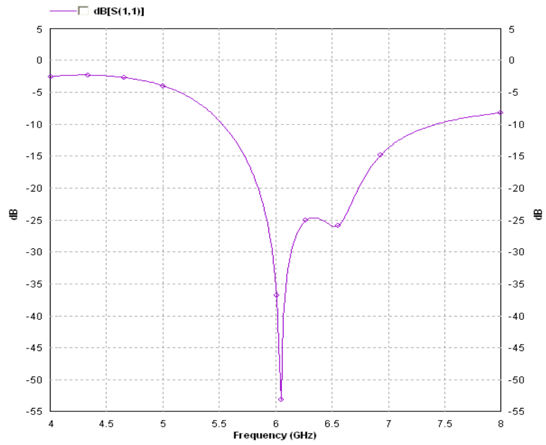

Fig. 2(a). Return Loss

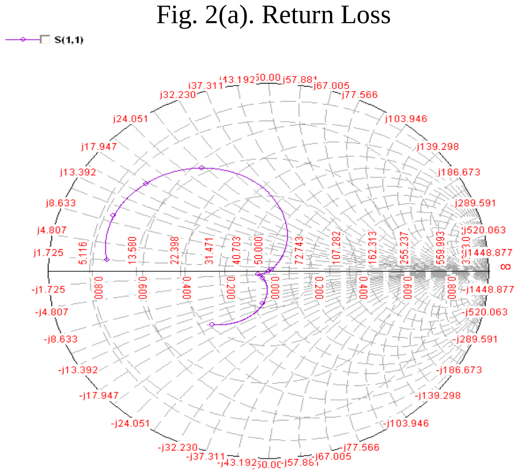

Fig. 2(b). Smith Chart

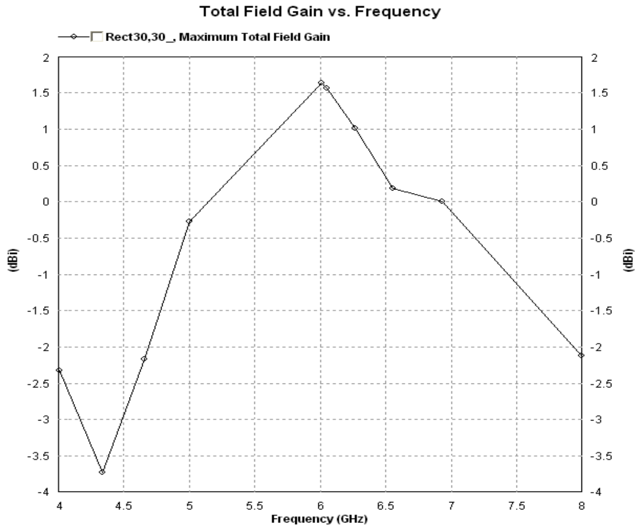

Fig.3. Gain

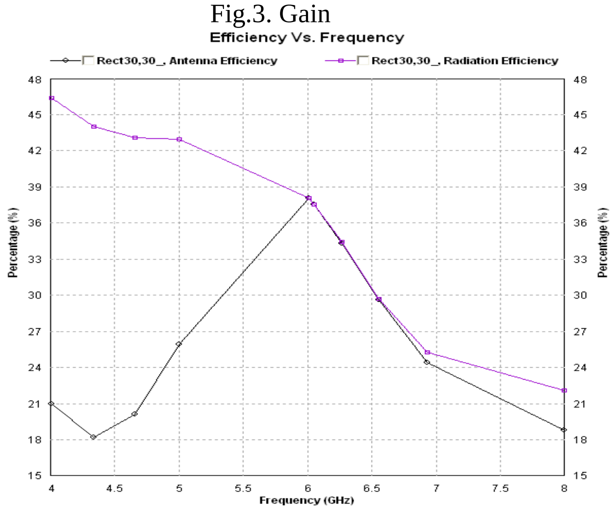

Fig.4. Efficiency(Antenna and Radiation Efficiency)

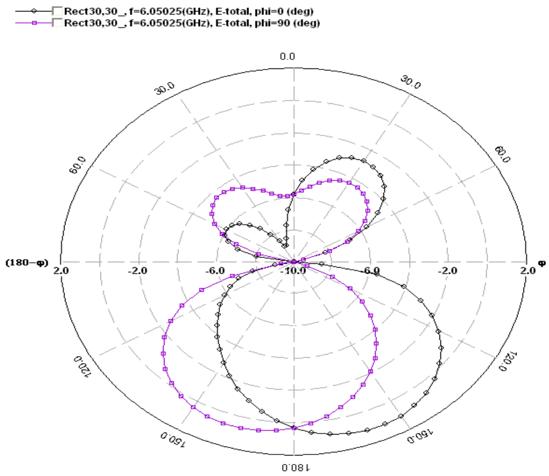

Fig. 5. Radiation Pattern at 6.048 GHz

Figure 4 shows both antenna and radiation efficiency i.e, 37.59 % and 37.59%. Figure 5 shows 2D radiation pattern of microstrip patch antenna at 6.048GHz.The proposed design with-out ground truncating is also fed at same point [4].

4. CONCLUSION

This paper presents the design and performance of a dual-frequency broadband MSA with finite ground plane. The modified rectangular patch antenna resonates at 6.048GHz frequency with improved bandwidth 31.22%, which is nearly seven times higher than that of a conventional circular patch antenna operating under similar test conditions. The resonant frequency have shifted after the finite ground truncating. The gain of antenna is also improved marginally, but it is still lower than desired value. These modern communication systems require antennas with broadband and/or multi-frequency operation modes. These goals have been accomplished employing optimization of ground dimensions, with the aim to preserve compactness requirements and to maintain the overall layout as simply as possible and keeping the realization cost very low.

(A.1)

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