RECTANGULAR PATCH ANTENNA FOR INFINITE AND FINITE GROUND PLANE.

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ABSTRACT

Antennas with low profile, simple, light weight are in demand. In this paper rectangular patch antenna is described with both infinite and finite ground plane. Here, microstrip line feed method is used to excite the antenna This paper presents the design of rectangular patch antennae on FR-4 substrate with dielectric constant 4.4 with loss tangent 0.019.The dimension of antennae is 13.5mm x 18mm for resonant frequency of 5GHz.

Keywords -- Finite, Infinite, Low Profile, Microstrip Line Feed, Rectangular Patch, Resonant.

I. INTRODUCTION

Microstrip patch antennas are low profile, conformable to planer and non planer surfaces, simple and inexpensive to manufacture using advanced printed circuit technology. The rectangular patch is most widely used configuration. It is very easy to analyse using transmission-line model [1]. Antenna can be designed for both infinite and finite ground plane and different feeding techniques are available. Large the ground plane is, the lower the direction of maximum radiation and as the ground plane approaches infinite size, the radiation pattern approaches a maximum in the x-y plane. [2].Most of the analysis of antennas are based on an infinite ground plane and on other hand ground plane is necessarily limited. When ground plane size is reduced overall antenna size also reduces, but simultaneously back lobe size increases, directivity and gain decreases. This is limitation of ground plane size in microstrip antenna. Conventional microstrip antennas assume infinitely large ground plane dimensions and thus they are large in size. Hence, their radiation patterns are comparatively directional with a relatively higher directivity. Since in practice, microstrip antennas must have finite ground plane, its effect should be considered in the analysis and design procedures. [3].

II. RELATED WORK

Lier, E.; Jakobsen, K[4] has been analysed the rectangular microstrip patch antenna with regard to its input impedance and resonant frequency, both for infinite and finite ground plane dimensions. L. Lolit Kumar Singh, Bhaskar Gupta, Partha P Sarkar [3] has been presented the review on the analysis of finite ground plane microstrip antenna. Lusekelo Kibona [2] has been analyzed the impact of rectangular plane ground on the radiations pattern of the monopole antenna. After this literature survey in this paper the design of rectangular patch antenna for infinite and finite ground with dimension 13.5mm x 18 mm is presented.

III. ANTENNA DESIGN

The proposed antenna is designed with basic rectangular patch with dimensions length of 13.5 mm and width 18 mm FR-4 substrate with dielectric constant 4.4 and loss tangent of 0.019.Height of substrate is 1.5 mm, resonant frequency 5GHz.. Microstrip line feed is used to excite the antenna. The feed point must be located at that point where input impedance is of 50 Ohm for resonant frequency. Therefore a trial and error method is used to locate feed point. The design steps are as follows

1. Calculation of the Width (W): The width of the Microstrip patch antenna is given by [1] equation.

$$W = \frac{c}{2 f_o \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

$$c = 3 \times 10^8 \, m / s$$

$$\varepsilon_r = 4.4$$

$$f_o = 5 GHz$$

$$W = 18.25 \, mm$$

2. Calculation of Effective dielectric constant ($\varepsilon_{r\,eff}$)

$$\varepsilon_{r\,eff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2} \left[\frac{1}{\sqrt{1 + \frac{12\,h}{W}}} \right]$$

$$h = 1.5 mm$$

$$\varepsilon_{r\,eff} = 3.90$$

3. Calculation of the Effective length (L eff)

$$L_{eff} = \frac{c}{2 f_o \sqrt{\varepsilon_{r\,eff}}}$$

$$L_{eff} = 15 \, mm$$

4. Calculation of the length extension (ΔL)

$$\Delta L = 0.412 \, h \frac{\left(\varepsilon_{r\,eff} + 0.3\right)\left[\frac{W}{h} + 0.262\right]}{\left(\varepsilon_{r\,eff} - 0.258\right)\left[\frac{W}{h} + 0.813\right]}$$

$$\Delta L = 0.68 \, mm$$

5. Calculation of actual length of patch (L)

$$L = L_{eff} - 2\Delta L$$

$$L = 13.6 mm$$

6. Calculation of the ground plane dimensions (L_g and W_g)

$$L_g = 6h + L$$
$$L_g = 22.6\,mm$$
$$W_g = 6h + W$$
$$W_g = 27.2\,mm$$

For simplicity, the length and the width of the Rectangular patch and the ground plane have following values L = 13.5mm, W = 18 mm, L_g = 22.5 mm, W_g= 27 mm

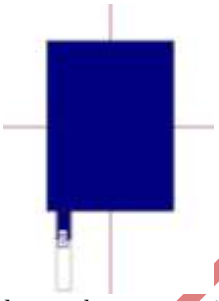


Fig.1 Geometry of Rectangular patch antenna with infinite ground plane [5]

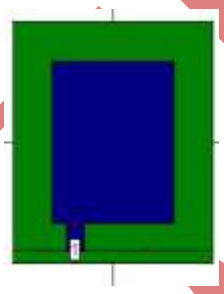
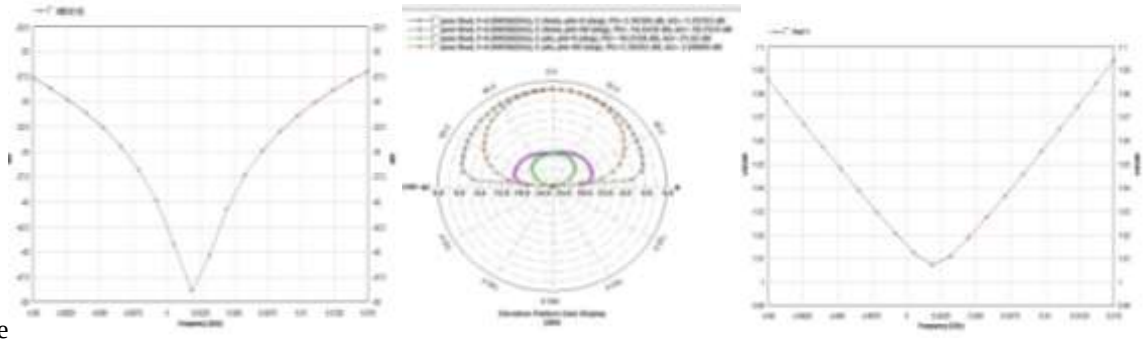


Fig.2 Geometry of Rectangular patch antenna with finite ground plane

IV. SIMULATION RESULTS

The results for designed antenna are shown in figure 3, 4 and table from 1 to 5. The result includes return loss, radiation pattern and VSWR for rectangular patch with finite and infinite ground plane



(a) (b) (c)

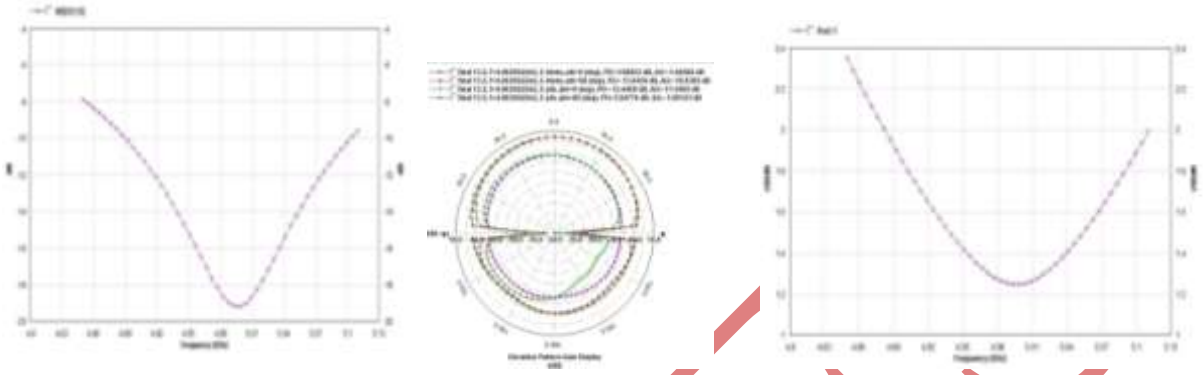
Fig. 3. Rectangular Patch Antenna(infinite ground plane) (a) Return loss (b) Radiation Pattern 2D (c) VSWR

Table 1 Return loss of Rectangular patch antenna (infinite ground plane)

Freq(GHz)	dB[S(1,1)]
5.001	-48.87

Table 2 VSWR for Rectangular patch antenna (infinite ground plane)

Freq(GHz)	Port 1
5.001	1.007



(a) (b) (c)

Fig. 4 Rectangular Patch Antenna(finite ground plane) (a) Return loss (b) Radiation Pattern 2D (c) VSWR

Table 3 Return loss of Rectangular patch antenna (finite ground plane)

Freq(GHz)	dB[S(1,1)]
4.998	-19.17

Table 4 VSWR for Rectangular patch antenna (finite ground plane)

Freq(GHz)	Port 1
4.998	1.246

Table 5 Comparison of simulated results

	Resonant frequency	Return loss in dB	VSWR	Gain dBi
Rectangular patch (infinite ground plane)	5.001GHz	-48.87	1.007	3.38
Rectangular patch (finite ground plane)	4.998 GHz	-19.17	1.246	3.94

V. CONCLUSION

In this paper antenna has been designed and simulated for infinite and finite ground plane for resonant frequency of 5GHz.After comparing result it is concluded that resonant frequency slightly changed, return loss increased VSWR increased and gain also increased.

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