Single Microstrip Patch Antenna for WLAN Application

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Abstract: *This paper covers Microstrip antenna designs. It includes the analysis and design of single element rectangular Microstrip antenna which operates at the central frequency of 2.40 GHz designed and simulated. Design The simulation process has been done through IE3D electromagnetic software. For rectangular Microstrip antenna design used RT- Duriod which is Teflon based, Microstrip board with dielectric constant 2.4 and the substrate height is 1.58 mm, The properties of antenna such as bandwidth, S-Parameter has been investigated..*
Keywords: *Microstrip Patch Antenna, S-Parameters, VSWR, IE3D.*

I. INTRODUCTION

As shown in Figure 1.1, conventional Microstrip antennas consist of a pair of parallel conducting layers separating a dielectric medium, referred as substrate. In this configuration, the upper conducting layer or "patch" is the source of radiation where electromagnetic energy fringes off the edges of the patch and into the substrate. The lower conducting layer acts as a perfectly reflecting ground plane, bouncing energy back through the substrate and into free space. Physically, the patch is a thin conductor that is an appreciable fraction of a wavelength inextent. The patch which has resonant behavior is responsible to achieve adequate bandwidth.

Conventional patch designs yield few percent band widths. In most practical applications, patch antenna is rectangular or circular in shape; however, in general, any geometry is possible.
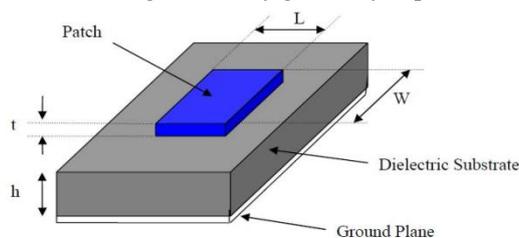
Figure 1.1 Rectangular Microstrip antenna.

Microstrip antenna should be designed so that its maximum wave pattern is normal to the patch. This is accomplished by proper choice of mode of excitation beneath the patch. Generally, patch of Microstrip antenna thickness is very thin in the range of $t<< \lambda_0$ (λ_0 is free space wave length) and the height h of dielectric material is between $0.003\lambda_0 < h < 0.05\lambda_0$. For a rectangular path, the length L of the element is usually $\lambda_0/3 < L < \lambda_0/2$

There are numerous substrate that can be used for the design of Micro strip antenna, and their dielectric constants are usually in the range of $2.2 < \varepsilon_r < 10$, where ε_r is relative dielectric constant. The substrate whose size is thick and dielectric constant is in the range of lower end provides better efficiency and bandwidth but it expenses large element size.

II. FEEDING TECHNIQUE

Microstrip Feed line

To design microstrip antenna Microstrip feed line is used. In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch as shown in Figure 2.1. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position. Hence this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching. However as the thickness of the

dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna [1]. The feed radiation also leads to undesired cross polarized radiation.
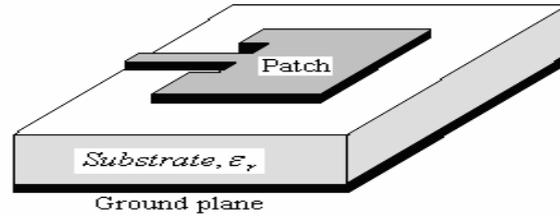
Figure2.2 Microstrip Line feeding.

III.   GEOMETRY OF MICROSTRIP PATCH ANTENNA

The detailed design of microstrip patch antenna with microstrip line feeding shown in figure 1.1, in this design choosing Substrate is as crucial as design itself. Many different factors as dielectric constant, thickness as well as loss tangent are considered. the following relationships are used to calculate the dimensions of rectangular microstrip patch antenna.

Effective dielectric Constant
$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{1/2}$$
Effective Length
$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$
Extension of length
$$\Delta L = 0.412h\,\frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{w}{h} + 08\right)}$$
Length of Patch
$$L = L_{eff} - 2\Delta L$$
Resonant Frequency
$$f_r = \frac{v_0}{2L\sqrt{\varepsilon_r}}$$
Width of the Patch
$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r + 1}}$$
Length of ground Plane
$$L_g = 6h + L$$
Width of ground plane
$$W_g = 6h + W$$
Inset depth of the microstrip Feed
$$y_0 = 10^{-4}\{0.001699\varepsilon_r{}^7 + 0.3761\varepsilon_r{}^6 - 6.1783\varepsilon_r{}^5 + 93.187\varepsilon_r{}^4 - 682.69\varepsilon_r{}^3 + 2561.9\varepsilon_r{}^2 - 4043\varepsilon_r$$
$$+ 6694\}\frac{L}{2}$$
Width of the Microstrip Feed
$$\frac{W_t}{t} = \frac{W}{t} + \frac{1.25h}{\pi t}\left[1 + ln\left(\frac{4\pi w}{h}\right)\right] \qquad \text{For } \frac{W}{t} \le \frac{1}{2\pi}$$
$$\frac{W_t}{t} = \frac{W}{t} + \frac{1.25h}{\pi t}\left[1 + ln\left(\frac{2t}{h}\right)\right] \qquad for\ \frac{W}{t} \ge \frac{1}{2\pi}$$

The Detailed Dimensions of microstrip patch antenna description is given in the table,Various parameters adre considered whiledoing the simulation for our desiging pupose we are using substrate material as Rogers RT/duriod the relative permittivity of which is 2.2 and electric loss tangent is 0.0001

Table1: Dimensions of Rectangular patch antenna

Sl. No	Antenna Parameters	Antenna Dimensions
1	Width of the Patch(W)	46.9 mm
2	Effective dielectric constant of the Patch	2.24
3	Length of the Patch(L)	39.6 mm
4	Input Resistance of the Patch (Rin)	50 Ω
5	Inset Depth of the Patch y0	13 mm
6	Width of Microstrip line (w0)	4.2 m

IV. DESIGN RESULTS

The simulation is done in IE3D (Method of Moments). The simulated result of S11 scattering parameter(return loss) of rectangular microstrip antenna is shown in figure 4.1

The simulated S11 parameter for the desired antenna was calculated and the simulated return loss results shown in fig 4.1. The bandwidth at the resonating frequency is 4.2GHz with corresponding return loss value of -45db.the antenna covers the WLAN standard. The return loss value i.e.-45db is good matching at the frequency point below -10db region.
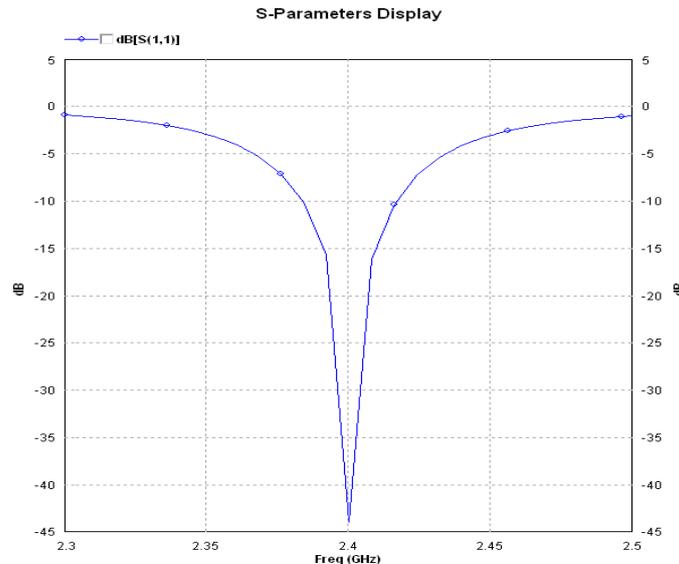
Fig 4.1: Scattering Parameter of a rectangular Patch antenna.

The desired antenna impedance is 53.23 ohms at F=2.40GHz shown in fig 4.2 which is very near to therequired impedance 50 ohms
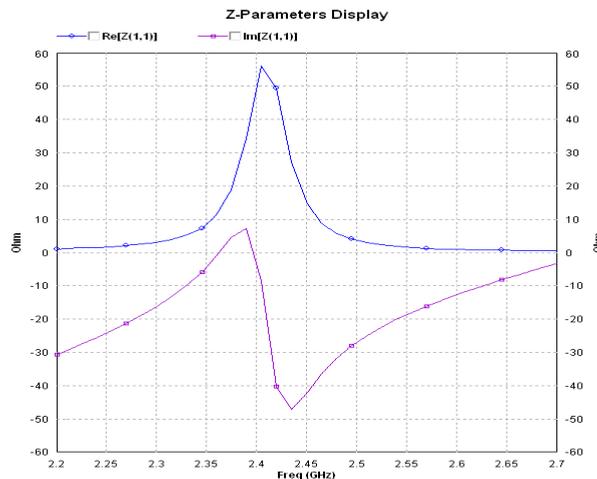
Figure 4.2 Input Impedance of Patch antenna at 2.40582GHz is 50

Figure 4.3 shows the simulated antenna gain at operating frequency of 4.2 GHz, the gain of desired antenna is 6.61.db.general the gain of antenna is between 5-8db.the desired antenna gain is good matching with the Theoretical valve.

Figure 4.4 shows the simulated antenna VSWR valve at operating frequency of 4.2 GHz, the VSWR Value of desired antenna is 1.01.which lies between desired antenna VSWR value
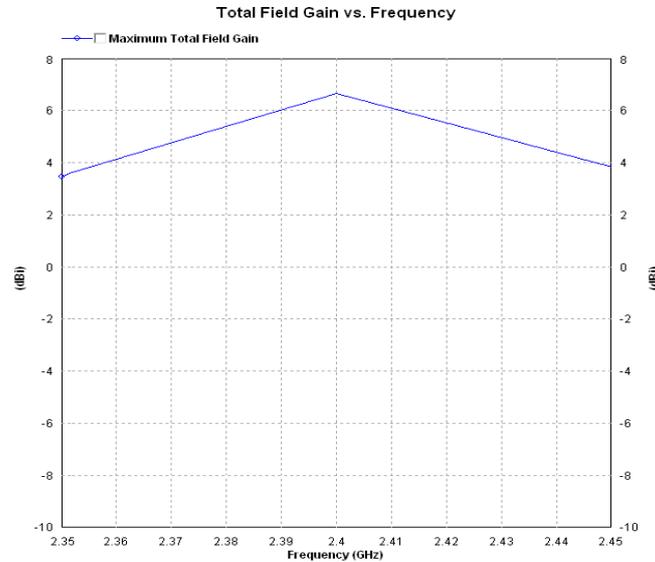
Figure 4.3: Gain of the patch is 6.61 dB at f= 2.40002 GHz
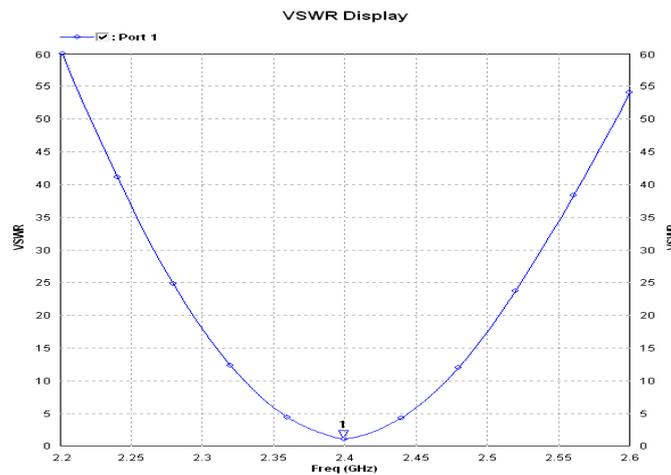
Figure 4.4 VSWR of Microstrip patch antenna is 1.0 at f=2.3995 GHz

V. CONCLUSION

Microstrip antenna for WLAN Application using microstrip feed is proposed and successfully implemented. The antenna presented in this paper is most suitable for LAN applications, from the results (figure 4.1to figure4.4) it is found that for antenna operating at the resonant frequency. This proposed microstrip antenna enhanced the impedance bandwidth and provides good matching. This antenna is simulated by using IE3D.

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