International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-2 Issue-5, June 2013

Design & Analysis of Rectangular Microstrip Patch Antenna

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Abstract— In this paper the design consideration for the rectangular microstrip antenna is present. The various parameters of rectangular microstrip antenna, input impedance, VSWR, return loss, radiation pattern have been investigated as a function of frequency for different feed locations with a view to optimize the feed location for proper matching and radiations. The proposed antenna is designed at the height of 1.5mm from the ground plane and this design is operated at 1.9GHz. The entire simulation work is done on IE3D software.

Keywords---Rectangular Microstrip Antenna, Return loss.

I. INTRODUCTION

In the recent years the development in communication systems requires the development of low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a wide spectrum of frequencies. The future development of the personal communication devices will aim to provide image, speech and data communications at any time, and anywhere around the world. This indicates that the future communication terminal antennas must meet the requirements of multi-band or wideband operations to sufficiently cover the possible operating bands. The performance of the fabricated antenna was measured and compared with simulation results. In modern wireless communication systems, the microstrip patch antennas are commonly used in the wireless devices. Therefore the miniaturization of the antenna has become an important issue in reducing the volume of entire communication system.

In modern wireless communication systems, the microstrip patch antennas are commonly used in the wireless devices. The demand in commercial and military wireless systems is due to capabilities of proposed Antenna such as low weight, low profile, low cost, easily combined with de-sign and technology, and relatively simple fabrication. All these antennas can also fabricate using IE3D simulation software and get very sharp characteristics. Proposed RMPA can be largely used in many wireless communication systems because of their low profile and light weight Microstrip antennas are largely used in many wireless communication systems because of their low profile and light weight.

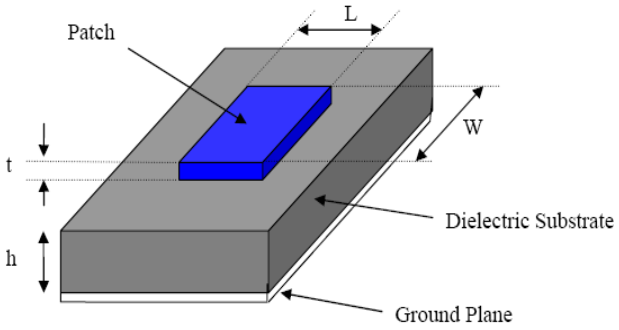

Figure: structure of microstrip patch antenna

The important parameters of any type antenna are impedance bandwidth and return loss. The impedance bandwidth depends on parameters related to the patch antenna element itself and feed used. The bandwidth is typically limited to a few percent.

II. DESIGN SPECIFICATION

The Rectangular microstrip patch antenna parameters are calculated from the following formulas.

A. Calculation of With (W):

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Where

c =free space velocity of light

ε_r=Dielectric constant of substrate

B. The effective dielectric constant of the rectangular microstrip patch antenna:

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{w}}}\right)$$

C. Calculation of the effective length:

$$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$$

D. Calculation of length extension:

$$\Delta L = 0.412h\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)}$$

E. Actual length of the patch (L):

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

Manuscript published on 30 June 2013.
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III. ANALYSIS OF PATCH ANTENNA AND MATEMATERIAL STRUCTURE WITH SIMULATED RESULTS

The Rectangular Microstrip patch Antenna designed at 1.9 GHz frequency, dielectric constant ε_r =11.9 and height from the ground plane h= 1.5 mm. The parameter of Rectangular microstrip patch antenna are L=22.8 mm, W=31.1 mm.
The simple Rectangular Microstrip patch Antenna is designed at 1.9 GHz.

Table. 1 Rectangular Microstrip Patch Antenna Specifications

Parameter	Dimension	Unit
Dielectric constant	1.9	GHz
Resonant frequency	1.9	GHz
Height	1.5	Mm
W	31.1	mm
ε_{reff}	10.7871	-
L_{eff}	24	mm
L	22.8	mm

A. Return Loss Plot

The results tabulated below are obtained after varying the feed location along the length of the patch from the origin (center of patch) to its right most edge. The coaxial probe feed used is designed to have a radius of 0.5mm. A frequency range of 1.7-2.1 GHz is selected and 401 frequency points are selected over this range to obtain accurate results. The optimum feed point is found to be at (4,0) where return loss is -31.3585 db is obtained. The bandwidth of the antenna for this feed point location is calculated to be 23.28 MHz and a center frequency of 1.9120 GHz is obtained which is very close to the desired design frequency of 1.9 GHz. Figure. 1 below shows the return loss plots for some of the feed point locations. It is observed from the table that, as the feed point location is moved away from the center of the patch, the center frequency starts to55 decrease slightly. It is also seen that though the maximum return loss is obtained at 4, 0, the maximum bandwidth is obtained at 4.75,0.

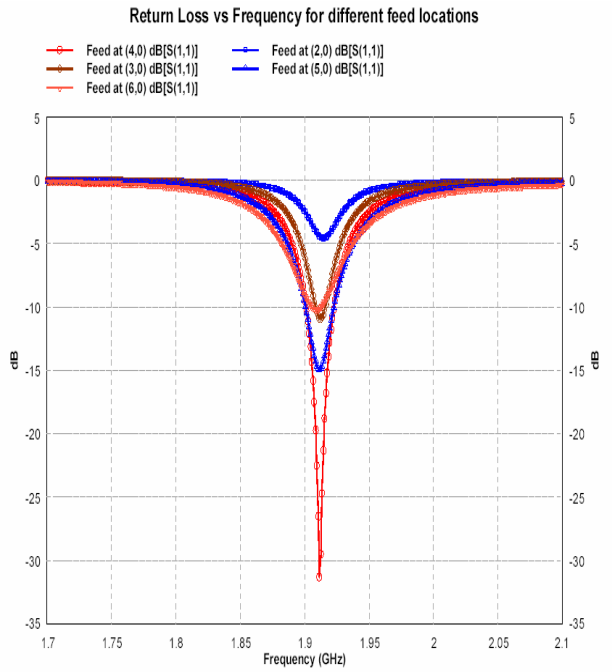

Fig.2 Return loss for feed located at different locations using IE3D

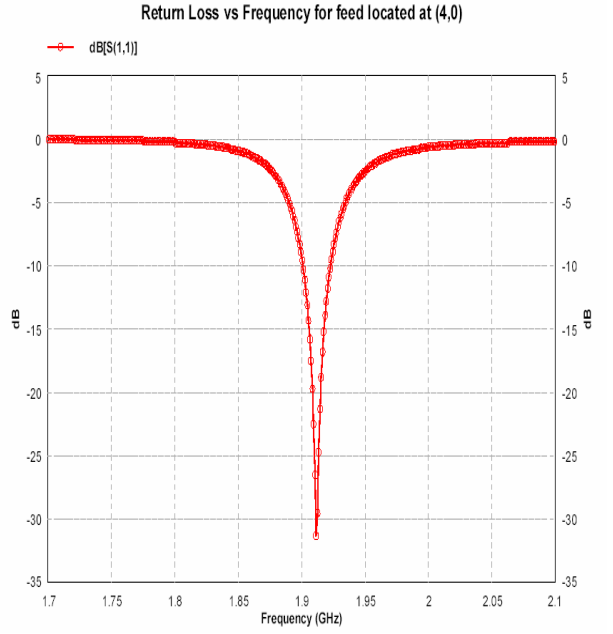

Fig.3 Return loss for located at (4,0)

B. Radiation Pattern plots

Since a microstrip patch antenna radiates normal to its patch surface, the elevation pattern for φ = 0 and φ = 90 degrees would be important. Fig. 4 below shows the gain of the antenna at 1.9120 GHz for φ = 0 and φ = 90 degrees. The maximum gain is obtained in the broadside direction and this is measured to be 1.87 dBi for both, φ = 0 and φ = 90 degrees. The backlobe radiation is sufficiently small and is measured to be -5.3 dBi for the above plot. This low backlobe radiation is an added advantage for using this antenna in a cellular phone, since it reduces the amount of electromagnetic radiation which travels towards the users head.

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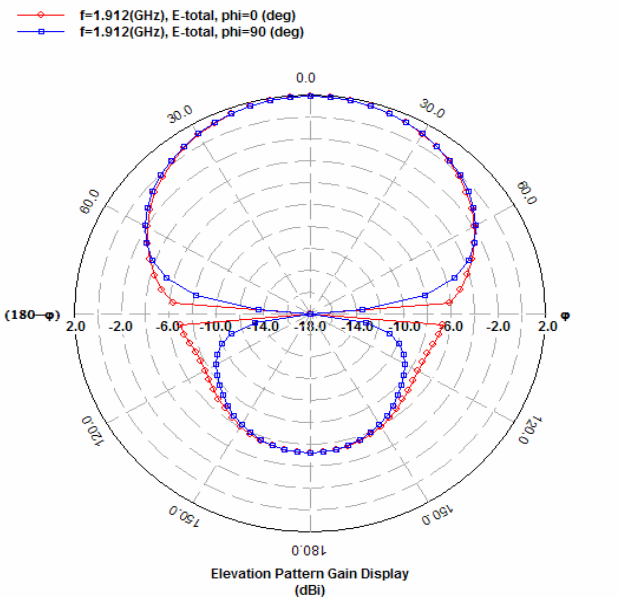

Fig.4 Elevation Pattern for φ = 0 and φ = 90 degrees

IV. CONCLUSION

The design, simulation, fabrication, and testing proved to be successful on some strata. The original goal of creating an antenna for TV signal broadcasting was not meet due to the large size required. The testing of the aluminum antenna on silicon substrate was regrettably not realizable due to limited availability of equipment; however it could prove to be an area of interesting future study. The rectangular planar antenna on duroid substrate did function according to the design and simulation with a resonance of 900MHz. further research could include optimization of the location of the feed point. The development of system such as satellite communication, highly sensitive radar, radio altimeters and missiles systems needs very light weight antenna which can be easily attached with the systems and which does not make the system bulky. These requirements are main factors for the development of proposed rectangular microstrip patch antenna.

ACKNOWLEDGEMENT

The authors wish to thank their parents for their constant motivation without which this work would have never been completed. The authors are grateful to the Prof. Rajeev Kumar at IFTM University Moradabad, for providing us lab facilities to complete this project work. I also express my gratitude to-wards Mr. Yogesh Kumar.

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