ISSN : 2231-0711
Amish Kumar Jha et al IJCSET | June 2011 | Vol 1, Issue 5,249-252

Performance of Microstrip Antenna of Different Substrates and Geometries for S-Band

Amish Kumar Jha , Bharti Gupta

Department of electronics & communication SIRT College Bhopal-462041 India

Abstract— **In this paper, many techniques are suggested and analyses for rectangular microstrip antenna (RMSA) operating in S-band for 3 GHz as center frequency. Using transmission-line model, analysis was done for the behavior of the antenna for different types of substrates, modified patch geometries and shifted feeding point, operating at S-band (2 to 4GHz). This design of RMSA is made to several dielectric materials, and the selection is based upon which material gives a better antenna performance with reduced surface wave loss. Glass PTFE and Duroid 5880 are the best materials for proposed design to achieve an enhanced Bandwidth (BW) and better mechanical characteristics than using air. These results are simulated using Feko EM solution software version 6.0.**

Keywords— **Microstrip antenna, Feko EM solution, Input impedance, Quarts, VSWR, Glass PTFE.**

I. INTRODUCTION

During the last decades a high development of the technology has arise in high- performance aircraft, spacecraft, satellite, telecommunications, and missile applications, where size, weight, cost and performance are constraints. To meet these requirements, microstrip antenna can be used [1]. A microstrip patch antenna consists of patch, substrate, ground plane and feeding point shown in fig. 1. A patch is a two-dimensional antenna element,

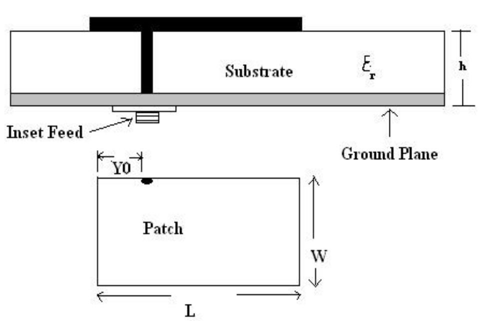

Fig. 1: Basic Microstrip antenna with inset-feed

which is often rectangular in shape. It is of a very thin thickness (t) of metallic strip on top of a material known as the substrate with thickness h (h«λo, usually 0.003λo≤h≤0.05λo, where λo is free space wavelength) above ground plane [1]. For rectangular patch, the length L of the element is usually λo/3<L<λo/2. The strip (patch) and the ground plane are separated by a dielectric (substrate). There are numerous substrates that can be used for the design of microstrip antennas, and their dielectric constants usually in the range of 2.2≤ εr ≤ 12. In this paper, many techniques are suggested and analyses for rectangular microstrip antenna operating in S-band.

II. DESIGN OF SINGLE PATCH RECTANGULAR MICROSTRIP ANTENNA

Three methods of analysis are commonly used to calculate microstrip antenna (MSA) parameters [1,2]. These are: Transmission line model, cavity model, and full wave analysis [8]. It is useful to model the microstrip antenna as a transmission line out of which transmission model is the simplest of all and it gives good physical insight but it is less accurate. It represents the MSA by two slots of width W and height h, separated by a transmission line of length L. The microstrip is essentially a non homogeneous line of two dielectrics, typically the substrate and air. An effective dielectric constant (ε_{eff}) must be obtained in order to account for the fringing and the wave propagation in the line. The expression for ε_{eff} is given by [1,2,3].

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

$$\text{for } \frac{W}{h} > 1$$

The resonance frequency for the (1, 0) mode is given by

$$f_0 = \frac{c}{2L\sqrt{\varepsilon_r}} \quad (2)$$

Where, c is the speed of light in vacuum. To account for the fringing of the cavity fields at the edges of the patch, the length, the effective length L_e is chosen as

$$L_e = L + 2\Delta L \quad (3)$$

The very popular and practical approximate relation for the normalized extension of the length is [1]

$$\frac{\Delta L}{h} = 0.412\,\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)} \quad (4)$$

For efficient radiation, the width W is given as

$$W = \frac{C}{2f_0\frac{\sqrt{\varepsilon_r+1}}{2}} \qquad (5)$$

The position of the inset feed point [6] where the input impedance is 50 Ω.
Given by the

$$R_{in(y=0)} = \frac{1}{2(G_1 \pm G_2)} cos^2\left(\frac{\pi}{L}y\right) \qquad (6)$$

III. SIMULATION AND RESULT

All In this section, a documentation of results is presented. This result includes the simulation and test of the suggested modified shape microstrip antenna (MSMSA) and the effect of variation in the dielectric constant [4, 5] of different material and variation in the feeding point, whose results were given in table 1 and table 2.

TABLE I
SUBSTRATE MATERIALS WITH EFFECTIVE DIELECTRIC CONSTANT

Substrate material	Dielectric constant (ε_r)	Frequency f_0 (GHz)	Loss tangent value (δ)	Effective dielectric constant (ε_{eff})
FR 4	4.4	3	0.017	4.0152
D Glass	4.0	3	0.0001	3.6694
Quartz	3.7	3	0.0026	3.4088
RT-Duroid-5880	2.2	3	0.0011	2.0878
Glass PTFE	2.17	3	0.0004	2.0604

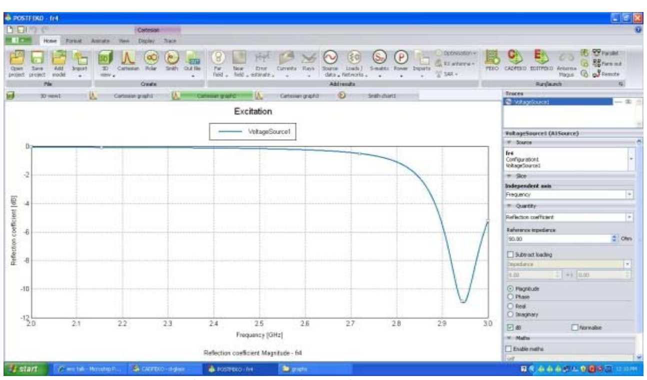
Fig. 2: Return loss of FR-4

Simulation result for each Substrate material of different dielectric constant is represented in the given figure.

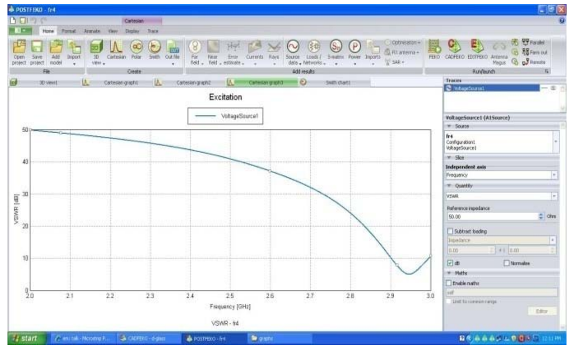
Fig. 3: VSWR of FR-4

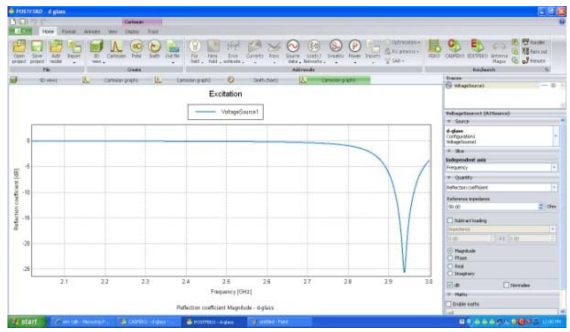
Fig. 4: Return loss of D Glass

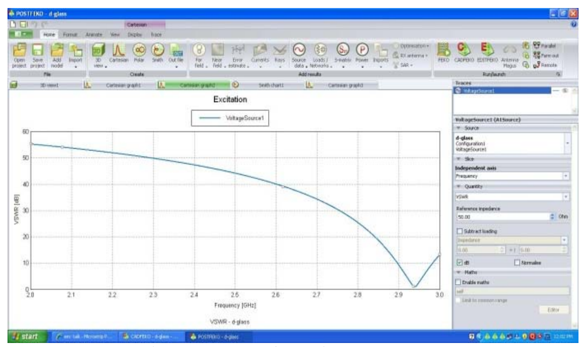
Fig. 5: VSWR of D Glass

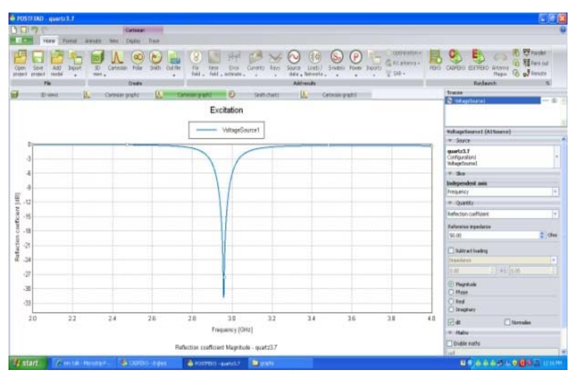
Fig.6: Return loss of Quartz

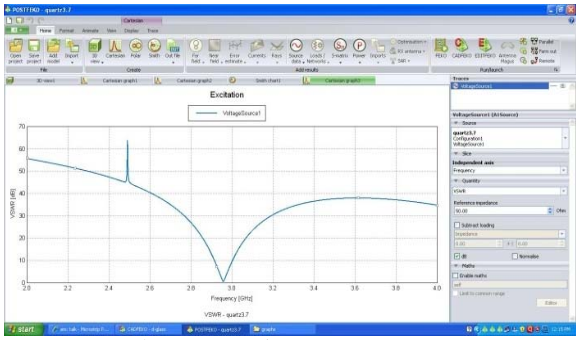

Fig. 7: VSWR of Quartz

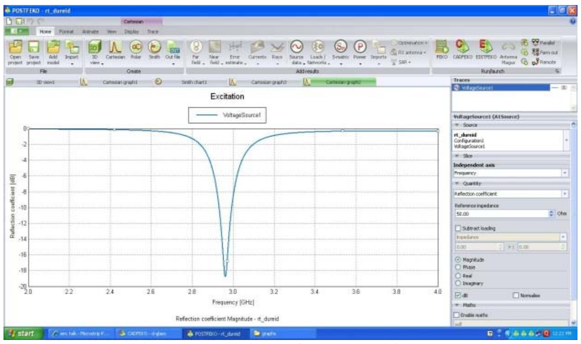

Fig. 8: Return loss of RT Duroid-5880

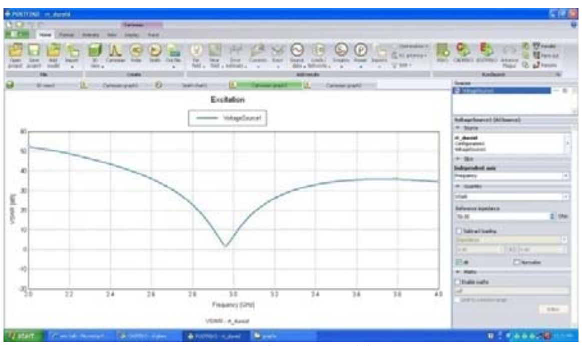

Fig. 9: VSWR of RT Duroid-5880

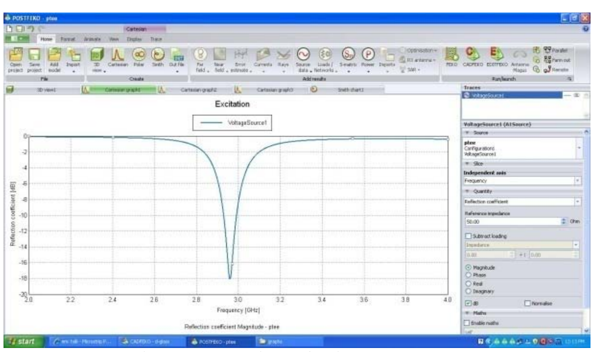

Fig. 10: Return loss of Glass PTFR

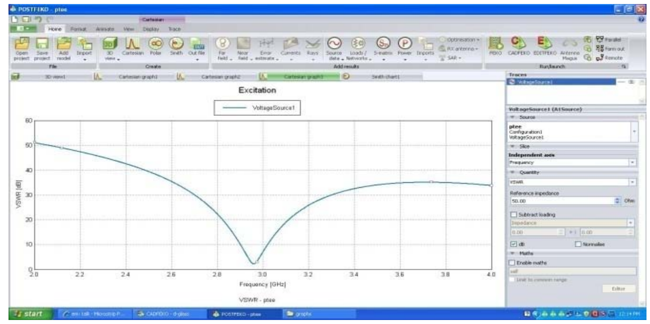

Fig. 11: VSWR of Glass PTFR

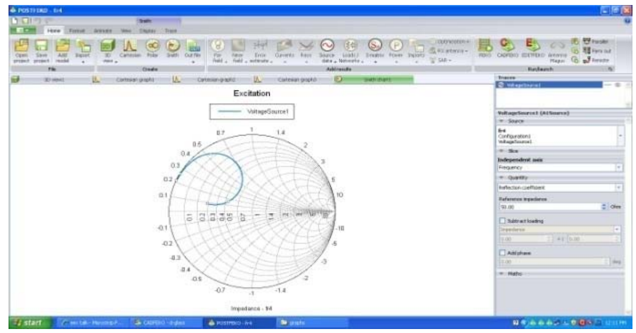

Fig. 12: Input Impedance of FR-4

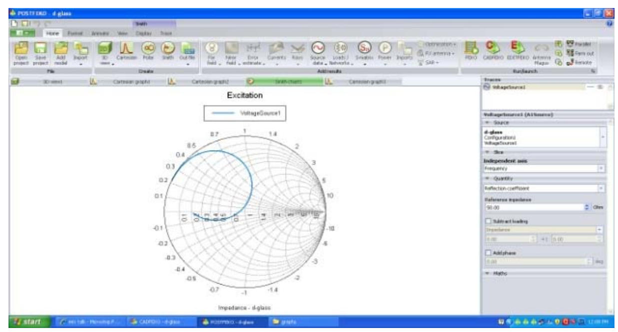

Fig. 13: Input Impedance of D Glass

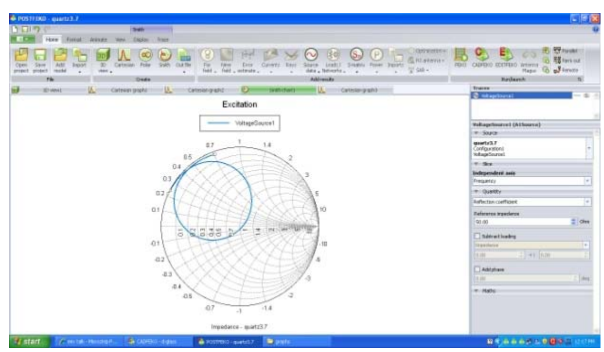

Fig. 14: Input Impedance of Quartz

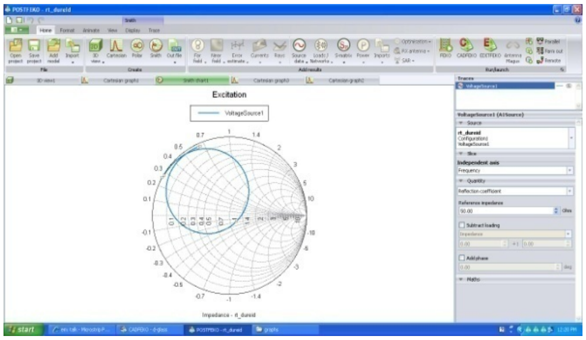

Fig. 15: Input Impedance of RT Duroid-5880

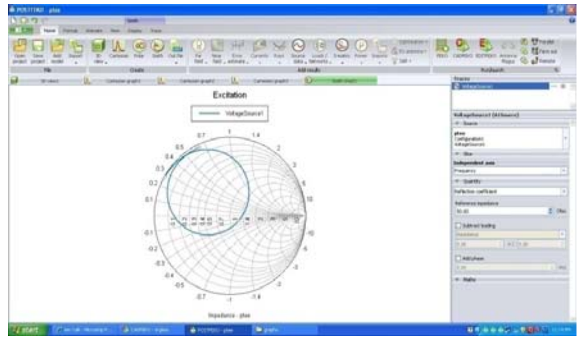

Fig. 16: Input Impedance of Glass PTFR

TABLE II
DIFFERENT PARAMETER AND THE RESULT OF SIMULATION

Substrate material	Dielectric constant (ε_r)	Frequency f_0 (GHz)	Bandwidth at -10dB in (GHz)	VSWR (dB)	Input Impedance (Ohm)	Length of Patch (mm)	Width of Patch (mm)	Feed point y_0 (mm)	Height (mm)
FR 4	4.4	3	0.03	10.5	243	23.39	30.42	8.91	1.7
D Glass	4.0	3	0.03	13	225	24.64	31.62	8.47	1.7
Quartz	3.7	3	0.04	10	211.5	25.47	32.61	8.61	1.7
RT-Duroid-5880	2.2	3	0.18	6.5	144	32.82	39.52	9.82	1.7
Glass PTFE	2.17	3	0.20	6.5	142.65	33.03	39.71	9.85	1.7

In table 2 we presented the detailed result of various material with its dimension, input impedance, VSWR, feed point and bandwidth at -10dB [6,7].

IV. CONCLUSION

Patch Antenna analysis has been presented. Firstly, the resonant frequency, size and feed location, the parasitic effects (such as fringing, dielectric, ground plane, etc.), and fundamental parameter are modeled Secondly the parameter such as: size, the effective resonant frequency, feed point location, etc., has been optimize and the numerical model investigated with the above equation and estimated. The selection of substrate materials used in this design processes is based on five materials, FR 4, D Glass, Quartz, Duroid 5880 and, Glass PTFE (Poly Tetra FluoroEthylene) [5]. Out of which Duroid 5880 and, Glass PTFE enhanced the bandwidth of the rectangular microstrip antenna which is achieved by using a method of shift feeding point position, and by modification of the patch shape.

REFERENCES

[1] Constantine A. Balanis; Antenna Theory, Analysis and Design, John Wiley & Sons Inc. 3rd edition. 2005.
[2] Wong, K. L. "Compact and Broadband Microstrip Antennas". NewYork: J. Wiley and Sons, 2002.
[3] Y.T. Lo. and S.W. Lee, editors, Antenna Handbook Theory, Applications and Design, Van Nostrand Reinhold Company, New York, 1988.
[4] Chen Wang , "Determining Dielectric Constant and Loss Tangent in FR-4 ". UMR Technical Report 2000.
[5] Brian Morin, Innegrity LLC, Greer, SC, "LOW DIELECTRIC FABRICS ".Us patent 7648758 , 2010.
[6] Design inset-fed Micro strip Patch Antennas, " www. Mwrf. com / Articles / ArticleID/69 93/6993.html. " 2008.
[7] Microstrip Patch Antenna Calculator, "www. emtalk.com/ mpacalc. php. " Tool.
[8] D. Orban and G.J.K Moernaut, "The Basics of Patch Antennas"www.orbanmicrowave. com/The_Basics_Of_Patch_Antennas.pdf, 2008.