Effect of Different Substrates on Microstrip Patch Antenna

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Abstract— Micro strip antennas are planar resonant cavities that leak from their edges and radiate. Printed circuit techniques can be used to etch the antennas on soft substrates to produce low-cost and repeatable antennas in a low profile. The antennas fabricated on compliant substrates withstand tremendous shock and vibration environments. Manufacturers for mobile communication base stations often fabricate these antennas directly in sheet metal and mount them on dielectric posts or foam in a variety of ways to eliminate the cost of substrates and etching. This also eliminates the problem of radiation from surface waves excited in a thick dielectric substrate used to increase bandwidth. A Micro strip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. In this work we are simulating Microstrip patch antenna using three different substrates. The designing has been done in IE3D software which is an EM solver and works on the principle of moments of method. Our main aim is to comparatively study different parameters of antenna such as Return Loss, Bandwidth, Gain, and Directivity & VSWR.

Key words: IE3D Software, Return Loss, Bandwidth, Gain and Directivity & VSWR

I. INTRODUCTION

Micro strip antennas are planar resonant cavities that leak from their edges and radiate. Printed circuit techniques can be used to etch the antennas on soft substrates to produce low-cost and repeatable antennas in a low profile. The antennas fabricated on compliant substrates withstand tremendous shock and vibration environments. Manufacturers for mobile communication base stations often fabricate these antennas directly in sheet metal and mount them on dielectric posts or foam in a variety of ways to eliminate the cost of substrates and etching. This also eliminates the problem of radiation from surface waves excited in a thick dielectric substrate used to increase bandwidth.

II. DESIGN OF RECTANGULAR MICROSTRIP PATCH ANTENNA

A. Antenna Design using FR4:

In this design of a micro strip patch antenna, FR4 dielectric material (εr = 4.4) with dielectric loss tangent of 0.025 is selected as the substrate with 1.6 mm height. Edge feeding is used as a feeding method. The design parameters are given in Table1.Using these parameters antenna is designed and simulated in IE3D simulator. [8]. The geometry of the designed antenna is shown in Fig.1 and the simulated results are shown in fig.2.and fig.3. This antenna has shown -25.7 dB return loss and bandwidth of 226MHz at 2.4GHz resonant frequency. At this frequency antenna radiate maximum transmitted power and reflects minimum power. The value of VSWR at this resonant frequency is 1.1. This antenna can be used for 2.4 GHz applications.

Length of the Patch	29mm
Width of the Patch	36mm
Length of the Ground Plate	39mm
Width of the Ground Plate	46mm
Length of the feed line	09mm
Width of the feed line	3mm

Table 1: Design Parameter of Microstrip Patch Antenna for 2.4 Ghz Using FR4

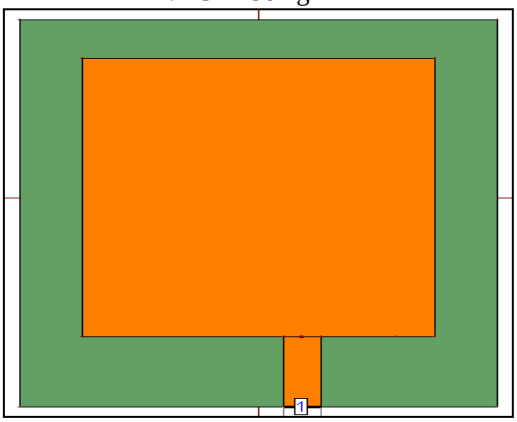

Fig. 1: Microstrip Patch Antenna Using FR4

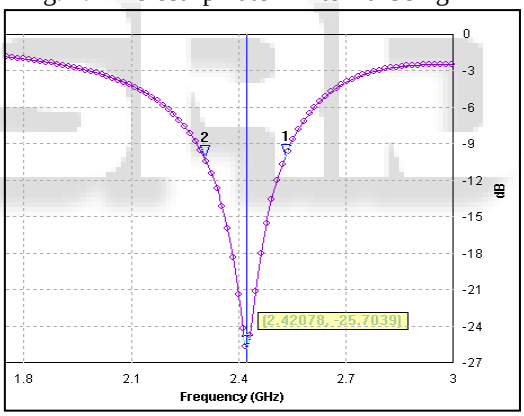

Fig. 2: Return Loss of Microstrip Patch Antenna with FR4 Substrate

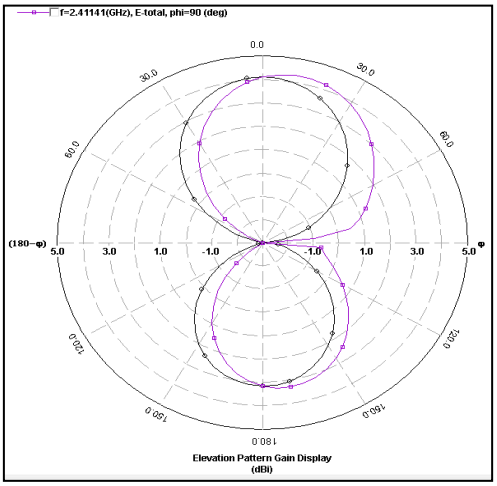

Fig. 3: Gain of Rectangular Microstrip Patch Antenna with FR4 Substrate at 2.4 Ghz

In this paper, this patch antenna is used as a reference antenna to design other antennas having the same patch but different substrates and Dielectric constants. At 2.4GHz resonance frequency antenna parameters Bandwidth, VSWR and Return loss is measured and analyzed.

B. Antenna Design using Rogers RO3006:

Rogers RO3006 dielectric material (εr = 6.50) with dielectric loss tangent of 0.02 is selected as the substrate with 1.28 mm height. Edge feeding is used as a feeding method. The design parameters are given in Table1 1.Using these parameters antenna is designed and simulated in IE3D simulator.[8-9]. The geometry of the designed antenna is shown in Fig.4 and the simulated results are shown in fig.5.and fig.6. This antenna has shown -25 dB return loss and bandwidth of 234MHz at 2.4GHz resonant frequency. At this frequency antenna radiate maximum transmitted power and reflects minimum power. The value of VSWR at this resonant frequency is 1.13. This antenna can be used for 2.4 GHz applications.

.Length of the Patch	25mm
Width of the Patch	33mm
Length of the Ground Plate	34mm
Width of the Ground Plate	46mm
Length of the feed line	8.97mm
Width of the feed line	1.8mm

Table 2: Design Parameter of Microstrip Patch Antenna for 2.4 Ghz Using RO3006

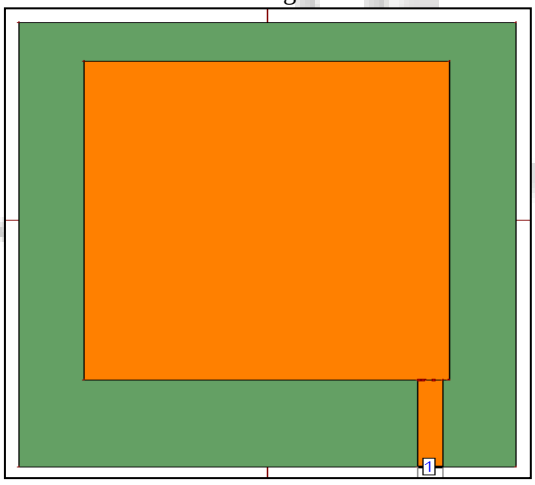

Fig. 4: Microstrip Patch Antenna Using RO3006

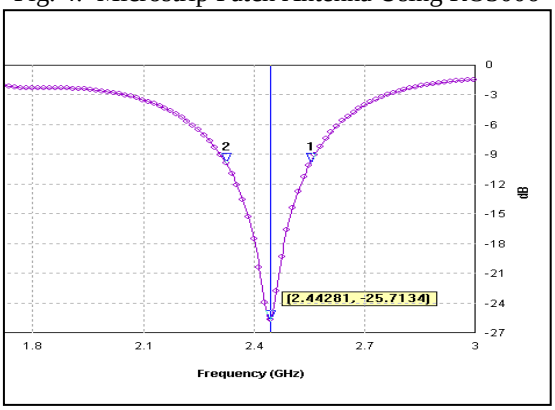

Fig. 5: Return Loss of Microstrip Patch Antenna with RO3006 Substrate

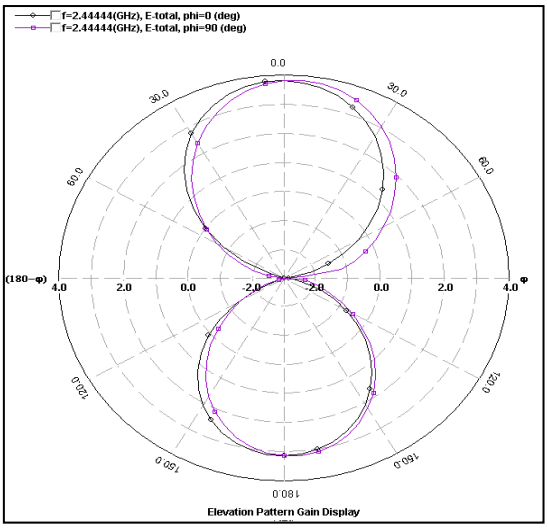

Fig.6: Gain of Rectangular Microstrip Patch Antenna with RO3006 Substrate at 2.4 Ghz

C. Antenna Design using Rogers RT5880:

Rogers RT5880 dielectric material (εr = 2.20) with dielectric loss tangent of 0.0009 is selected as the substrate with 1.575 mm height. Edge feeding is used as a feeding method. The design parameters are given in Table1 3.Using these parameters antenna is designed and simulated in IE3D simulator.[8]. The geometry of the designed antenna is shown in Fig.7 and the simulated results are shown in fig.8.and fig.9. This antenna has shown -18 dB return loss and bandwidth of 180MHz at 2.18GHz resonant frequency. At this frequency antenna radiate maximum transmitted power and reflects minimum power. The value of VSWR at this resonant frequency is 1.12. This antenna can be used for 2.18 GHz applications.

.Length of the Patch	41mm
Width of the Patch	48mm
Length of the Ground Plate	46mm
Width of the Ground Plate	54mm
Length of the feed line	06mm
Width of the feed line	2.38mm

Table 3: Design Parameter of Micro Strip Patch Antenna for 2.18 GHz Using RT5880

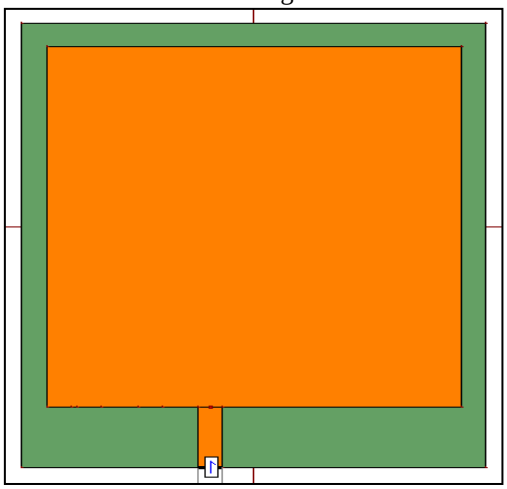

Fig. 7: Microstrip Patch Antenna Using RT5880

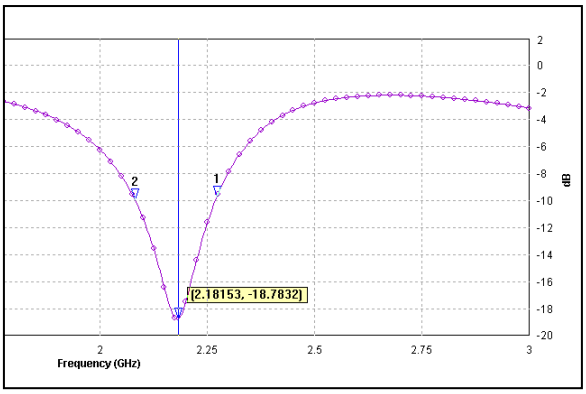

Fig. 8: Return Loss of Micro Strip Patch Antenna with RT5880 Substrate

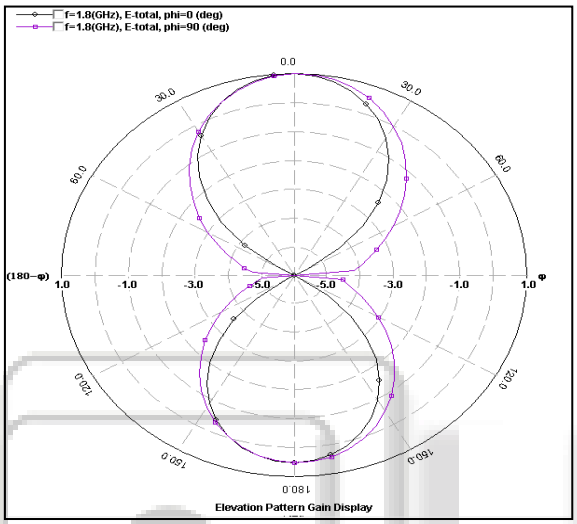

Fig. 9: Gain of Rectangular Micro Strip Patch Antenna with RT5880 Substrate at 2.18 Ghz

III. Result & Discussion

Parameters	FR4	RO3006	RT5880
Operating frequency	2.413GHz	2.44GHz	2.18GHz
Return Loss	-25.4dB	-25.7dB	-18.7dB
Bandwidth	226.65MHz	234MHz	180MHz
Gain	4.63dB	3.8dB	4.5dB
Directivity	4.66dB	3.85dB	4.58dB
VSWR	1.11	1.3	1.26

Table 4: Comparison of Different Substrates Results.

We presented a comparative study of the patch antenna using three different substrates. The overall working of antennas was understood. The major parameters (such as Return Loss curves, Radiation Patterns, Directivity) that affect design and applications were studied and their implications understood. Several patch antennas will be simulated (using Ie3D) and the desired level of optimization will be obtained. There is always a tradeoff between Gain and Bandwidth. It is our aim to ensure that the hardware and software results match the theoretically predicted results. For the increase in gain and bandwidth patch can be modified into various structures such as stacks, or arrays so that the gain of the antenna increases. Even by increasing the height of the substrate we can get a acceptable good gain ranges. Even using meta-materials as a substrate whose permittivity is negative it can increase the bandwidth and gain to a considerable amount.

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