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Study of EPA using Different Substrates

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Abstract: In wireless communication, Microstrip patch antennas are the type of most used printed antennas and have been widely applied in many sectors due to their advantages of being light weight, small size, low profile, low cost, large bandwidth. In this paper we have proposed to do comparative study of elliptical patch antenna (EPA) using FR4, Nylon fabric, Foam and Quartz substrates at fixed resonating frequency of 5GHz using co-axial probe feed technique. The simulation analysis was done by using Zealand IE3D software. The antenna parameters compared in this paper are **S11** (Return Loss), Gain, Antenna Efficiency, 2D radiation pattern, the impedance or percentage bandwidth. The return loss of FR4 is -35.978 dB, Nylon Fabric is -31.98222 dB, Foam is -34.0172 dB and Quartz is 25.11222 dB. The gain of the FR4 is 5.10279 dBi, Nylon Fabric is 4.80465 dBi, Foam is 9.53889 dBi and Quartz is 3.57836 dBi. The antenna efficiency of FR4 is 70.6515%, Nylon Fabric is 62.351%, Foam is 98.2056% and Quartz is 52.6998. The bandwidth of FR4 is 4.04%, Nylon Fabric is 4.8%, Foam is 8.3546 and Quartz is 1.444%. The proposed antenna can be used for Wi-Fi application.

Keywords: S11 (Return Loss), Gain, Antenna Efficiency, 2D radiation pattern, the impedance or percentage bandwidth.

I. Introduction

In telecommunication, a microstrip antenna (also known as printed antenna) usually means an antenna fabricated using photolithographic techniques on a printed circuit board (PCB). It is a kind of internal antenna. They are mostly used at microwave frequencies. So, FR4, Nylon fabric, Foam and Quartz substrates may be used to develop and simulate a circular patch antenna and elliptical patch antenna. The circular patch antenna and elliptical patch antenna at the same frequency band of 5GHz may be design and can compare with respect to the different substrates and the areas to be printed. The patch antenna designs may be simulated by using Zealand IE3D software. 5GHz frequency may be use for Wi-Fi.

II. Antenna Design

The geometry of the conventional EPA using Nylon substrate has the dimension of height (h) = 2 mm, dielectric constant (Ɛr) =3 .6, loss tangent = 0.0083, resonating frequency = 5 GHz and we assumed the radius on primary axis of EPA = 8.525 mm and radius on secondary axis of EPA = 8.1 mm. We assumed the probe radius 0.625 mm.

The geometry of the conventional EPA using Quartz substrate has the dimension of height (h) = 2 mm, dielectric constant (Ɛr) =4.2, loss tangent = 0.001, resonating frequency = 5 GHz and we assumed the radius on primary axis of EPA = 13.75 mm and radius on secondary axis of EPA = 13.73 mm. We assumed the probe radius 0.625 mm.

The geometry of the conventional EPA using FR4 substrate has the dimension of height (h) = 1.6 mm, dielectric constant (Ɛr) =4.4, loss tangent = 0.0025, resonating frequency = 5 GHz and we assumed the radius on primary axis of EPA = 7.64 mm and radius on secondary axis of EPA = 9 mm. We assumed the probe radius 0.625 mm.

The geometry of the conventional EPA using Foam substrate has the dimension of height (h) = 2 mm, dielectric constant (Ɛr) =1.05, loss tangent = 0, resonating frequency = 5 GHz and we assumed the radius on primary axis of EPA = 15.28 mm and radius on secondary axis of EPA = 16.6 mm. We assumed the probe radius 0.625 mm.

III. Simulated Results

The proposed antenna design was simulated using the software Zealand IE3D 12.0 and plots for return loss (S_{11}), Antenna efficiency, gain; etc. The simulated results are shown below:

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A. Return loss S_{11} and Bandwidth

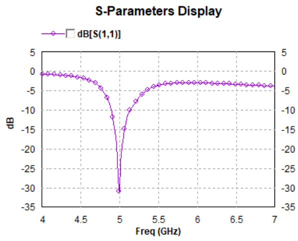

Fig. 1: R L for Nylon

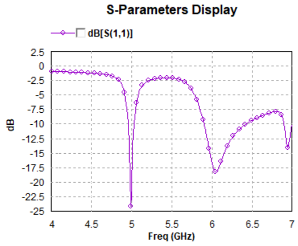

Fig.2: R L for Quartz

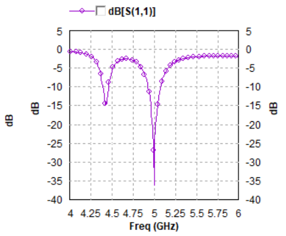

Fig.3: R L for FR4

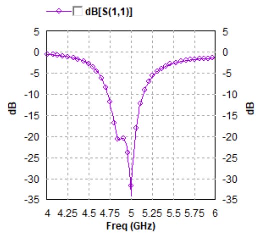

Fig.4: R L for Foam

B. Radiation Pattern

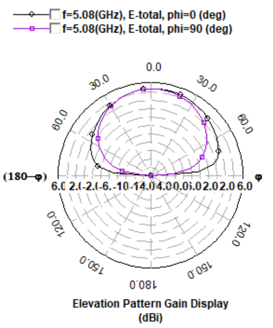

Fig.5: R P for Nylon

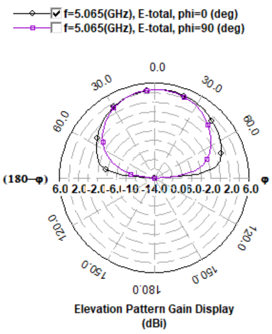

Fig.6: R P for Quartz

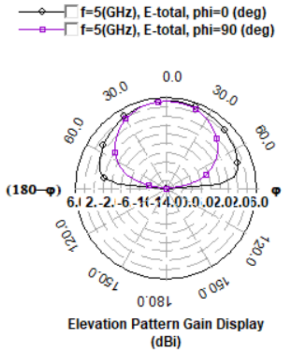

Fig.7: R P for FR4

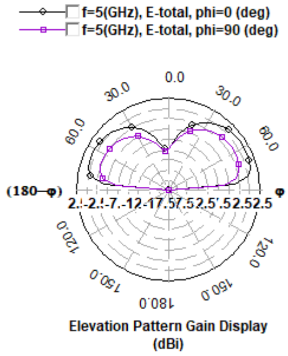

Fig.8: R P for Foam

C. Gain

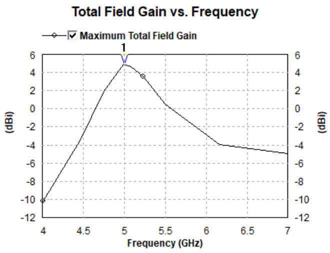

Fig.9: Gain for Nylon

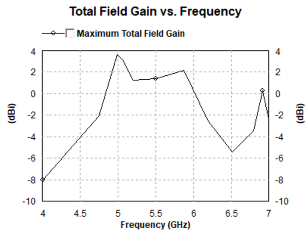

Fig.10: Gain for Quartz

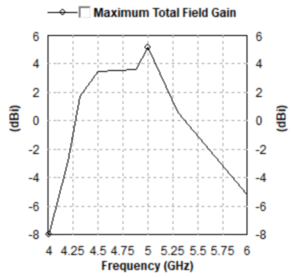

Fig.11: Gain for FR4

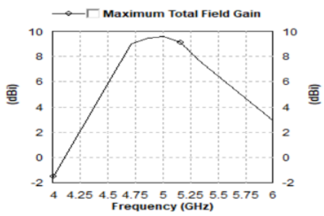

Fig.12: Gain for Foam

D. Antenna Efficiency

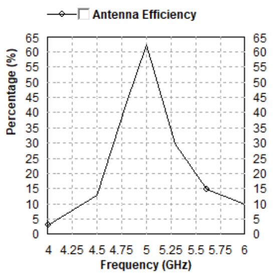

Fig.13: A E for Nylon

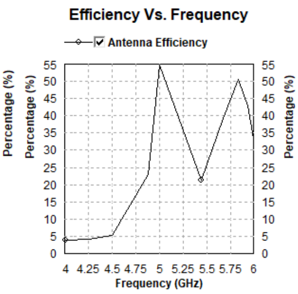

Fig.14: A E for Quartz

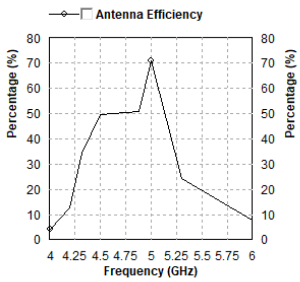

Fig.15: A E for FR4

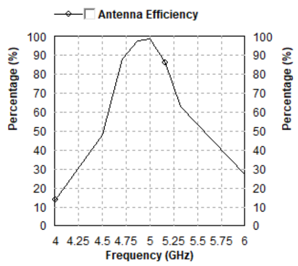

Fig.16: A E for Foam

IV.TABLE 1. Comparision Table

Sl. No.	Parameters	Substrates			
		Nylon Fabric	FR4	Quartz	Foam
1.	Height (h) (mm)	2	1.6	2	2
2.	Dielectric constant (Ɛr)	3.6	4.4	4.2	1.05
3.	Loss tangent	0.0083	0.0025	0.001	0
4.	Radius of Major axis and minor axis of EPA (mm)	a = 8.525 b = 8.1	a = 7.64 b = 9	a = 13.75 b = 13.73	a = 15.28 b = 16.6
5.	Return loss (s11) (dB)	-31.98222	-35.978	-25.11222	-34.0172
6.	GAIN (dBi)	4.80465	5.10279	3.57836	9.53889
7.	Antenna efficiency (%)	62.351	70.6515	52.6998	98.2056
8.	Fractional bandwidth (%)	4.8	4.04	1.4444	8.3546

V. Conclusion

In this paper the comparative study of NYLON, FR4, FOAM and QUARTZ substrates were used for designing EPA with the same resonating frequency of 5GHz. After comparison, it was found that the maximum fractional bandwidth, Antenna Efficiency and Gain were obtained from Foam substrate. Therefore, Foam substrate is much better for fabrication. In future the fractional BW of Foam EPA may be improved by cutting slot on the patch as well as on the ground. And hence the narrow BW may be improved.

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