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Design and Simulation of Dual BandMicro-strip Patch Antenna for Wireless Communication

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ABSTRACT

This paper proposes a patch antenna that uses Rectangular Slot as base construction. The simulation results show that an antenna with Rectangular Slot has improved bandwidth and return loss significantly by changing the Dielectric material. Experimental results indicate that the impedance bandwidth, defined by -18dB return loss, of the proposed wide slot antenna can reach operating bandwidth of 254MHz at the operating frequency about 7.13GHz which is 3 times greater than conventional Rectangular Microstrip Patch Antenna.

Keywords:— *Dual-band Antenna, Microstrip Patch Antenna (MPA).*

I. INTRODUCTION

The demand for the portable mobile devices is increasing progressively with the development of wireless communication techniques. In that respect, compact size, light weight, low profile and low cost are now quite important challenges to be accomplished by the designers for every wireless mobile component [5]. The field of Antennas is vigorous and dynamic and planar oriented antennas such as Microstrip Patch have attracted significant attention primarily for space borne applications. A microstrip antenna is characterized by its Length, Width, Input impedance, and Gain and radiation patterns. The microstrip antenna consists of conducting patch on a ground plane separated by dielectric substrate. This concept was undeveloped until the revolution in electronic circuit miniaturization and large-scale integration in 1970. After that many authors have described the radiation from the ground plane by a dielectric substrate for different configurations. The performance parameter of the single band MPA only works properly at the design frequency. Now we turn our attention on dual-band microstrip antenna meant for dual-frequency operation. To achieve dual-band response several strategies have been developed. In [2], this paper presents an S-shape loaded dual-band microstrip antenna designed for wireless & WLAN applications. In [3], a multi-band microstrip antenna was presented with a defects ground structure which is conventionally conformal and appropriate for

WLAN applications. In [4],this paper mainly focuses on the basic concept and characteristics of DGS structure using different dielectric materials. DGS structure is basically formed in periodic/non-periodic configuration defect etched into ground plane. A rectangular MPA with slots on patch and DGS structure into ground plane level was introduced. Without slots and DGS the MPA found to resonate on 5.22GHz and by introducing slots and DGS frequency shift of 5.22 GHz to 1.56 GHz was observed[5]. In [6], microstrip antenna using periodic cross strip-line gaps as DGS structure is created. The suitable comparison between the outcome of conventional antenna and DGS antenna with different dielectric materials has been present. In [7], a compact multi-band MPA using DGS was introduced. The design for the MPA consist an S-shaped slot on top of the patch along with DGS structure of U and L shape into ground plane level. In [8], MPA with I-shape DGS is introduce for improved bandwidth of 118% compared to conventional design. This antenna design also confirms additional improvement in parameters like return loss.

The concept of such antennas though introduced in the early 1950's in the US by Decamps& in France by Gutton & Baissinot, it was in the 1970's only that with the advent of Printed Circuit Technology, some serious advancement in this research area had begun [2]. A Microstrip device literally means a sandwich of two parallel conducting layers separated by single thin dielectric substrate. The lower conductor is called Ground Plane & the upper conductor is a simple resonant circular/rectangular Patch. The metallic patch (usually Cu or Au) may take many geometric viz. Rectangular, circular, triangular, elliptical, helical, ring etc.

II. Antenna Configuration

The configuration of proposed antenna is shown in figure 1. The proposed wide slot has a dimension of L & W and is printed on a substrate of thickness (h) relative permittivity =2.2. The printed wide slot is etched on ground substrate. The wide slot is fed by a 50-microstrip line. The basic rectangular slot microstrip-line-fed printed wide-slot antenna design-1 is shown in Figure 1. For exciting the operating frequency at around 6.2 GHz, the dimension of the square slot can be roughly determined by Where c is the speed of light in the air, is the effective relative permittivity and L is the length of the square slot.

Simple Rectangular Microstrip Patch Antenna Fed by Microstrip Line is shown in Figure 1. The Essential Parameters of The Design are shown in Table 1.

Table-1 Common Design Specification f Orbo than Tennas

S.N.	Specification	Dimensions
1	Ground Plane	Wg=30 mm, Lg=30mm
2	Substrate	Ws = 30mmLs = 30mmhs =1.6mm
3	Rectangular Patch	Wp = 12.67mmLp = 9.29mm
4	Permittivity of sub statematerial	2.294

III. Rectangular Patch Antenna

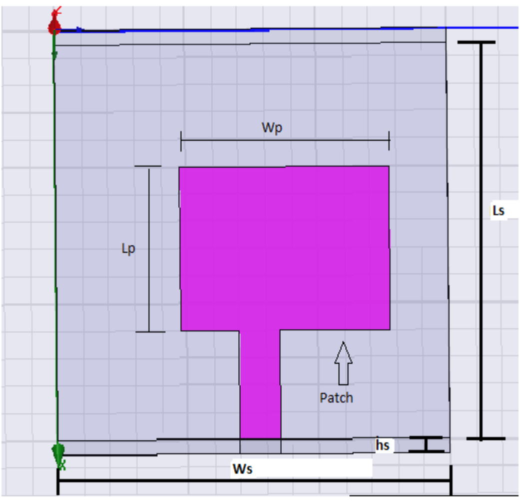

Figure 1: Conventional MPA (Microstrip patch Antenna)

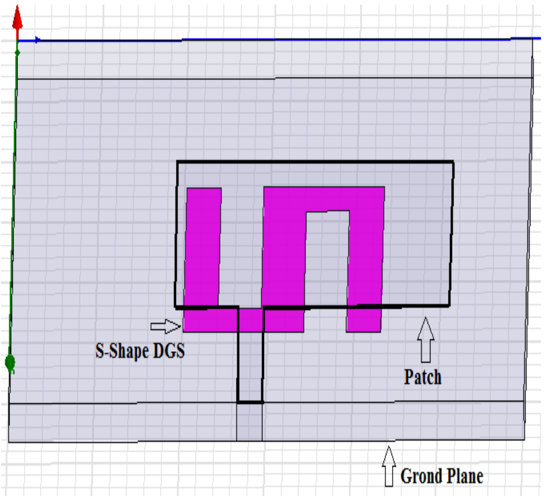

Figure 2: S-shape DGS MPA (Microstrip patch

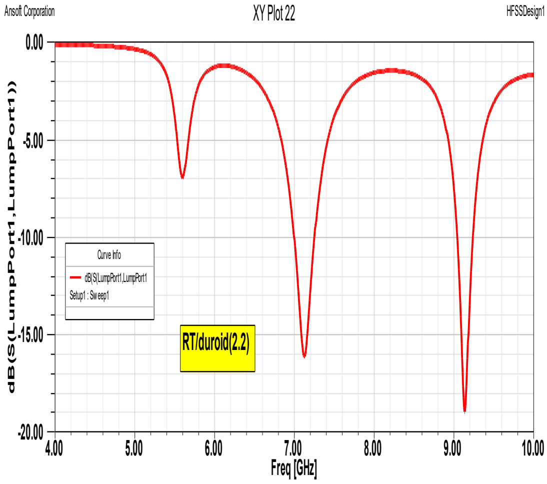

Figure 3(a) Return loss (S11) vs. Frequency

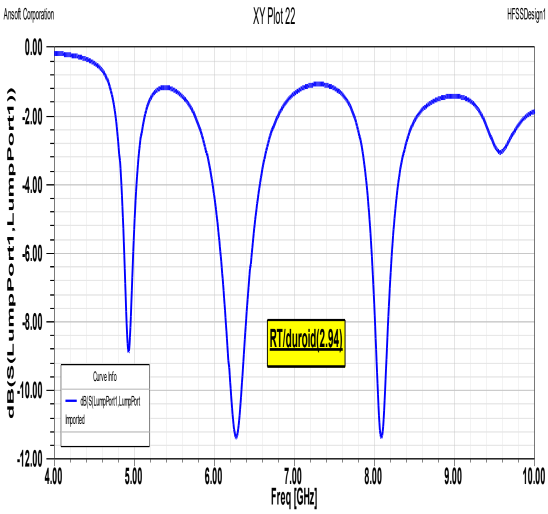

Figure 3(b) Return loss (S11) vs. Frequency

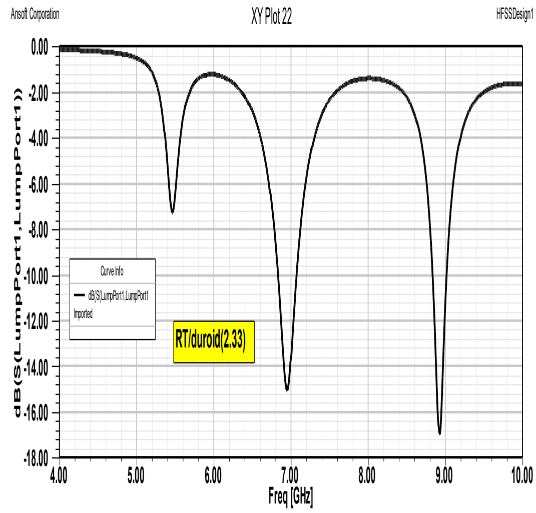

Figure 3(c) Return loss (S11) vs.Frequency

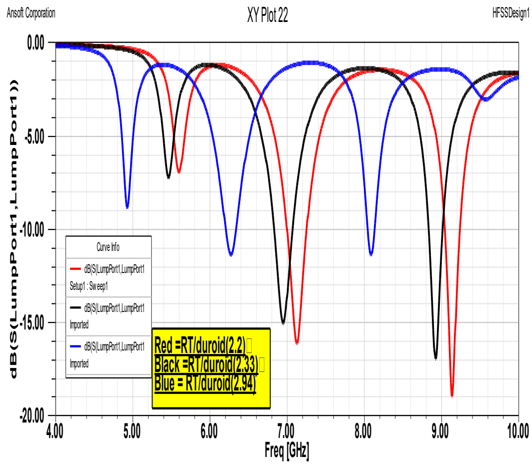

Figure 3(d) Return loss (S11) vs.Frequency

IV. METHODOLOGY

Width of metallic patch (W)

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}}$$

Where,

c = free space velocity of light

εr = Dielectric constant of substrate

The effective dielectric constant of the Microstrip antenna to account for fringing field.

Effective dielectric constant is calculated from:

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

Length of metallic patch (L)

L = Leff- 2ΔL,

Where $\text{Leff} = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}}$

Calculation of Length Extension

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

Calculation of VSWR

$$\text{VSWR} = S = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

Where r = Reflection Co-efficient

Calculation of Return Loss

When an electromagnetic wave travels down a transmission line and encounters a mismatched load or a discontinuity in the line, part of the incident power is reflected back down the line. The return loss is defined as

$$\text{Return Loss} = 20\log\,|\Gamma|$$

V. Results and Discussion

The outcome shown here is simulated on HFSS software to determine the characteristic parameter of design antenna like return loss & impedance bandwidth.

Dielectric Material for Substrate	Frequency (GHz)(at S11<-15dB)	Return Loss(dB)	Band width (MHz)
RT Duroid (2.2)	7.1361	-16.0659	254.4
	9.1538	-18.1572	177.5
RT Duroid (2.33)	6.9586	-14.9965	230.8
	8.9349	-16.6120	180.2
RT Duroid (2.94)	6.2781	-11.3584	138.1
	8.1006	-11.2399	82.2

The design of RMPA for 7.136GHz has been done. First of all necessary parameters are calculated by the formula for giving frequencies and after that by using HFSS Software the simulation is done by the calculated parameters. Using on the value of cut width and cut depth, the Return Loss is maximum -18.96dB Simulated Results. And Bandwidth Improvement is 14.3GHz.

VI. Conclusion

In this work it is found that the insertions of Slotted in Rectangular Shape at the ground plane of Rectangular Microstrip Patch Antenna ultimately enhance Bandwidth significantly. This had also been proven that the change in dielectric material effect reduces Return Loss of Antenna.

Rectangular Microstrip Patch Antenna can provide printed radiating structure, which are electrically thin, lightweight and low cost, is a relatively not too old.

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