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High Gain & Efficient Planner Array Antenna for Satellite Applications

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ABSTRACT

Globalization trend in Satellite Communication shows deep interest in Micro-strip antenna design. Development shows Micro-strip patch antenna design for the satellite communication for single band but least paper are available on double band in satellite communication, and making of array of patch antenna which is used for increasing in gain & improvement in various parameters like return loss, radiation pattern, VSWR, and gain. The proposed technique is used for designing a Micro-strip patch antenna and array of patch antenna at 4 GHz and after cutting the some part of patch, I get the second band at 6 GHz. Micro-strip patch antenna will be designed and fabricated at 4 GHz & 6 GHz. The stimulated results show significant improvement in the antenna parameters.

KEYWORDS : patch antenna, cutting plane, dual band, Array of patch antenna.

I. INTRODUCTION

MICROSTRIP antennas and arrays have found numerous applications in recent years over a wide range of frequencies from UHF up to millimeter waves. This is mainly due to their ease of manufacturing, low cost, compact size, and ease of integration with various planar circuit technologies[1]. Microstrips patch antennas with several advantages such as conformal nature, light weight, and easy of integration. Since compact antennas can achieve the same performance as large antennas do in a low price and ease with integration technology, reduction of antenna parameter is becoming an important design parameter. In this paper, firstly I make the simple patch antenna which have high gain, high directivity and high efficiency. After I make the array of microstrip patch array antenna(1x2) and getting the increasing in the gain which is the main factor of the communication systems. many wireless-communications systems, there is a require- ment for light, low-profile antennas. The reason is that these antennas are less obtrusive than traditionally used parabolic reflectors. In addition, snow, rain, or wind has less of an affect on their performance. A planar antenna, incorporating an array of microstrip patches, is one example of a low-weight, low-profile antenna. In order to make this array an effective radiator, each individual patch has to be suitably fed[3].

II. MICROSTRIP PATCH ANTENNA DESIGN

The geometry of the proposed antenna along with its parameters is shown in Fig. 1. The antenna was initially designed and developed on 0.8-mm thick Teflon(PTFE) substrate and fed by a coaxial probe which is operating at 4 GHz frequency.

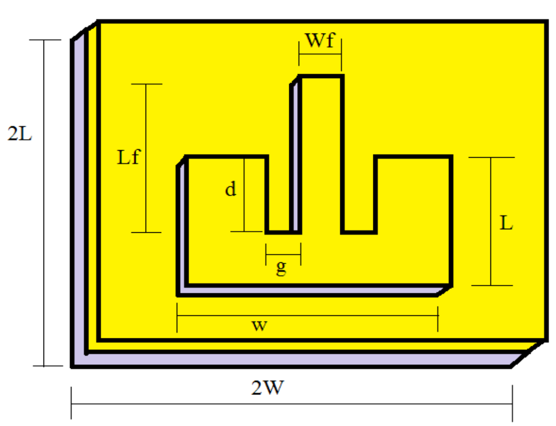

Fig. 1 Antenna geometrical configuration

Steps required for calculating antenna parameters:

1. Calculation of the width W of antenna:

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

f_r = resonant frequency

ε_r = Dielectric constant of the substrate

2. Calculation of Effective dielectric constant (ε_{reff}):

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}[1+12\frac{h}{W}]^{-\frac{1}{2}}$$

3. Calculation of Effective Length (L_{eff}): The effective length is calculated from the known frequency to which antenna is to be designed and dielectric constant of material

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

4. Calculation of Length Extension (ΔL): The extension length due to fringing field effect in the radiating patch is calculated given by

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

5. Calculation of Actual Length (L): From the fringing length the actual length of the patch is calculated given by [6]

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

Antenna parameters are calculated from the given equations and they are as under.

Parameters	Values
f_r	4 GHz

W	30.12
Wf	10
L	25.52
Lf	19
d	8.5
h	0.8
t	0.035
g	1.3
ε_r	2.1
Dielectric substrate	Teflon(PTFE)

Table 1. Antenna parameter and its value

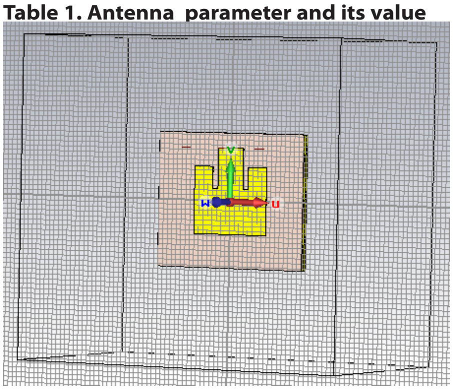

Fig. 2 CST view for proposed single antenna

III. DUAL BAND FOR SINGLE ELEMENT

Now, Making of dual band single antenna, first of all I cut the some part of the patch and simulate the cutting patch antenna, I get the second band at 6 GHz frequency, which is given in the figure below. The geometrical representations of dual band single element antenna show below with its parameters.

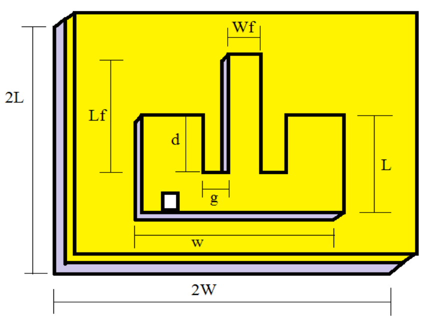

Fig. 3 geometrical representations of single dual band antenna

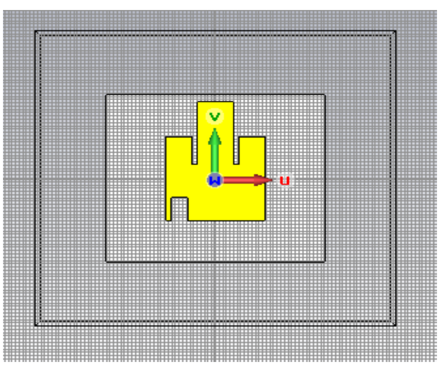

Fig. 4 CST view of dual band antenna

Parameters	Values
f_r	4 & 6 GHz
W	30.12
Wf	10
L	25.52
Lf	19
D	8.5
H	0.8
T	0.035
G	1.3
ε_r	2.1
Dielectric substrate	Teflon(PTFE)

Table 2. dual band Antenna parameter and its value

IV. RESULTS

A. MICRO STRIP PATCH ANTENNA

I using CST software for the simulation of simple antenna and dual band singe patch antenna. Polar plot for Gain and directivity for antenna and array antenna are as under.

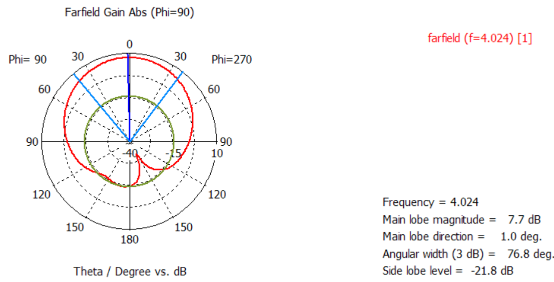

Fig. 5 Polar plot for gain for single band

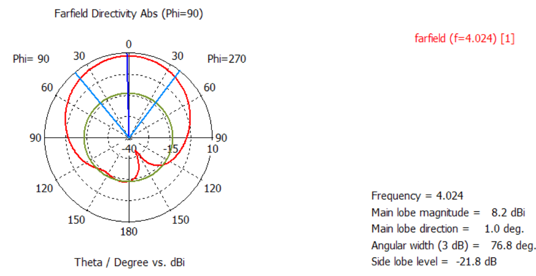

Fig. 6 Polar plot for Directivity for single band

Efficiency, Return loss, VSWR (voltage standing wave ratio) are the important parameter for the antenna. They are as under.

Parameters	Values
Return Loss	-33.707
VSWR	1.04
Gain	7.722
Directivity	8.224
Efficiency	93.89%

Table 3. Simulated Results

B. ARRAY ANTENNA(1x2)

A representation of S-parameter vs. frequency, at resonant frequency 4 & 6 GHz, as shown in figure 7.

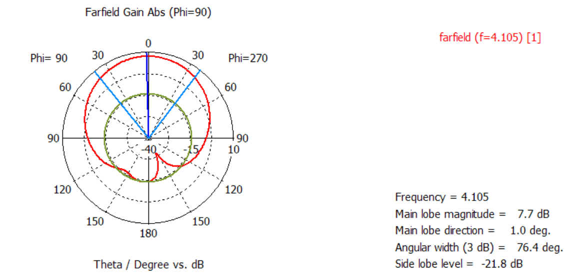

Fig. 7 Polar plot for Gain for 4.105 GHz

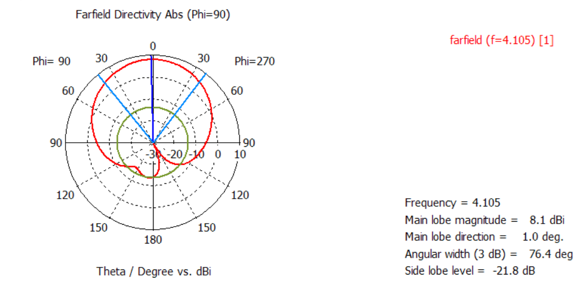

Fig. 8 Polar plot for directivity for 4.105 GHz

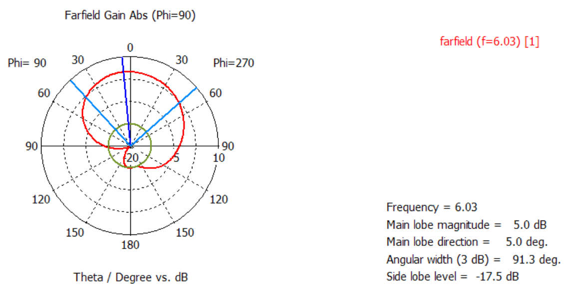

Fig. 9 Polar plot for Gain for 6.024 GHz

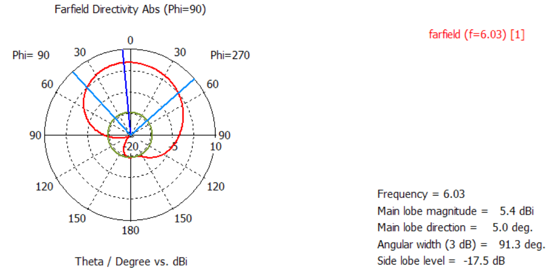

Fig. 10 Polar plot for directivity for 6.024 GHz

Parameters	Value at 4 GHz	Values at 6 GHz
Return Loss	-20.974	-32.633
VSWR	1.19	1.04
Gain	7.677	6.513
Directivity	8.100	6.948
Efficiency	94.77%	93.73%

V. CONCLUSION

In this paper, the performance of a single antenna and dual band antenna for satellite applications, with better efficiency and performance has been described.

From the simulation results, I can conclude that I make simple antenna which have high gain, directivity and efficiency at 4 GHz using Teflon(PTFE) substrate material and get second band at 6 GHz. I also concluded that I make array antenna which have also high gain, directivity and efficiency at 4 & 6 GHz togethering the single element.

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