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Dual Band Antenna for satellite Communication

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Abstract— This paper describes the design and analysis of a novel dual band antenna (with a Rogers RT/Duroid 6202 laminate substrate having dielectric constant 4.4) for satellite communication. The antenna is being designed by taking the substrate height as 1.6 mm, the length of the patch as 27.5 mm and the width of the patch as 38 mm. The length and width for slot 1 and slot 2 were taken as 33 mm and 2.4 mm respectively. Similarly the length and width of slot 3 and slot 4 were considered as 11.4 mm and 1mm. We have considered the feed point location as (8.6, 8.6) from the origin. The simulation results of proposed antenna are achieved with the help of IE3D zeland software (V-12.0) using transmission line and cavity models. The results are analyzed in terms of current distribution, elevation pattern, return loss and voltage standing wave ratio (VSWR). This antenna finds C band (4 GHz to 8 GHz) and X band (8 to 12 GHz) applications where it can be effectively used for satellite communication.

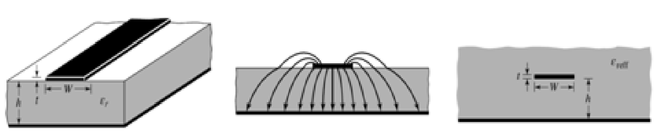
Keywords: Dual band antenna, Wireless communication, S and C band, IE3D.

I .INTRODUCTION

In high-performance applications, where less size, low weight, low cost and ease of installation are required a low-profile antenna like microstrip antennas, which are low profile, simple and inexpensive to manufacture can be used. This paper describes the design and analysis of a novel dual band antenna for satellite communication [1-3]. The simulation results of proposed antenna are done with the help of IE3D Zealand Software [4]. For the analysis we use transmission line model and cavity model.

II. MULTI BAND ANTENNA CONCEPT

The Multi-band planar antennas should operate with similar features at two or operating frequencies, having same polarization planes and broadside radiation patterns [5-7]. Fig. 1 describes the Microstrip line, its electric field lines and effective dielectric constant geometry of such an antenna.



(a) (b) (c)

Figure 1. (a) Microstrip line, (b) electric field lines and (c) effective dielectric constant geometry of a microstrip antenna.

A. Effective dielectric constant

This particular value of dielectric constant of the uniform dielectric material [Fig. 1(c)] has identical electrical characteristics (like propagation constant), as the actual line of Fig. 1(a). For a line with air above the substrate, the effective dielectric constant is a function of frequency. For low values of frequencies it is essentially constant. As the frequency of operation increases, most of the electric field lines concentrate in the substrate. The initial values, referred to as the static values (at low frequencies) of are given by

$$\varepsilon_{reff} = \frac{\varepsilon_{reff}+1}{2} + \frac{\varepsilon_{reff}-1}{2}\left[1+12\frac{h}{W}\right]^{1/2} \qquad (1)$$

Where W/h > 1

B. Effective Length

As a result of the fringing effects, electrically the patch of a microstrip antenna looks larger than its physical dimensions and an approximate relation for the normalized extension of the length is

$$\frac{\Delta L}{h} = 0.412\frac{\left(\varepsilon_{reff}+0.3\right)\left(\frac{W}{h}+0.264\right)}{\left(\varepsilon_{reff}-0.258\right)\left(\frac{W}{h}+0.8\right)} \qquad (2)$$

The effective length of the patch is

$$L_{eff} = L + 2\Delta L \qquad (3)$$

III.ANTENNA CONFIGURATION AND CHARACTERICS

The geometry of the proposed Dual Band Antenna is shown in Fig. 2.

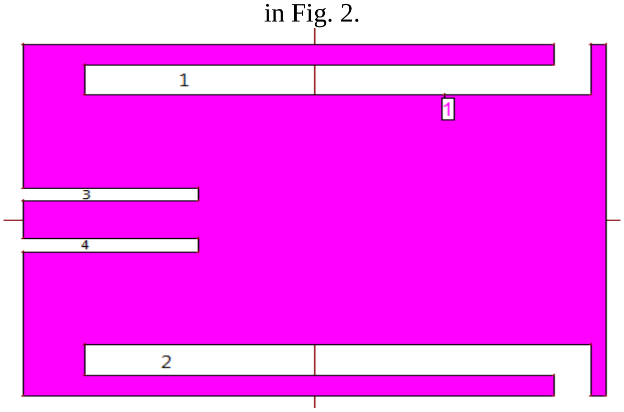
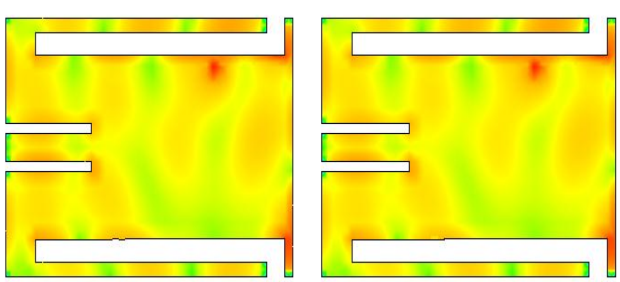


Figure 2. Dual Band Antenna

The antenna is designed on a Rogers RT/Duroid 6202 laminate substrate with dielectric constant = 4.4. The substrate height has been selected as 1.6 mm. The length of the patch is 27.5 mm and the width of the patch is 38 mm. The length and width for slot 1 and slot 2 were taken as 33 mm and 2.4 mm respectively. Similarly the length and width of slot 3 and slot 4 were considered as 11.4 mm and 1mm. We have considered the feed point location as (8.6, 8.6) from the origin. The simulation is done using the software IE3D [4].

A. Current Distribution

Figure 3 shows the current distribution at (a) 7.75 GHz and (b) 9.4 GHz respectively and can be observed with universal dB color measure scale.



(a) (b)

Figure 3. Current Distribution at (a) 7.75 GHz and (b) 9.4 GHz.

In Figure 4 it is shown that for a dual band antenna, return loss is acceptable at two frequencies, i.e. 7.75 GHz and 9.4 GHz. The value of return loss for two frequencies is -35 dB and -43 dB. In Fig. 5 the observed VSWR at 7.75 GHz and 9.4 GHz are 1.3 and 1.2 indicating that the level of mismatch is minimum.

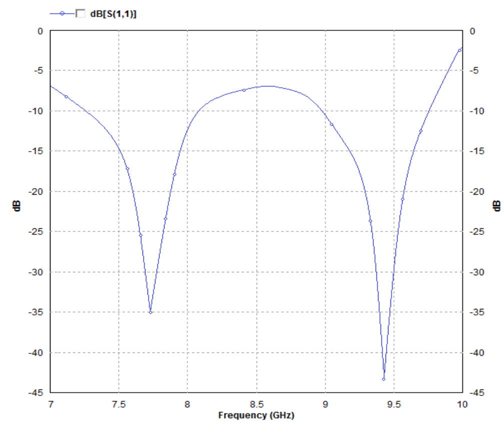


Figure 4. Return Loss

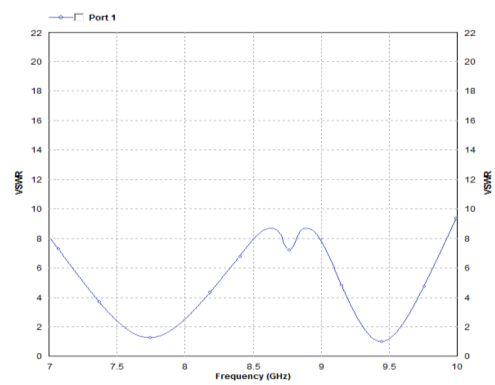
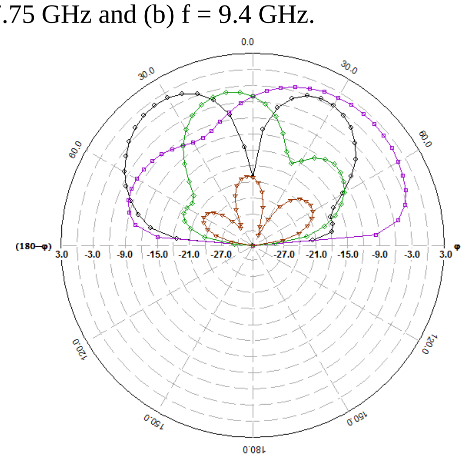


Figure 5.VSWR

Elevation pattern of directivity at ϕ = 00 and ϕ = 900 is shown in Figure 6, while that of gain is shown in Figure 7 for (a) f = 7.75 GHz and (b) f = 9.4 GHz.



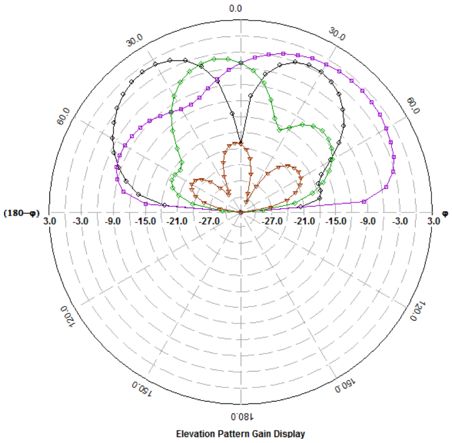


Figure 6. Elevation Patter Gain Display at f=7.75 GHz and 9.4 GHz

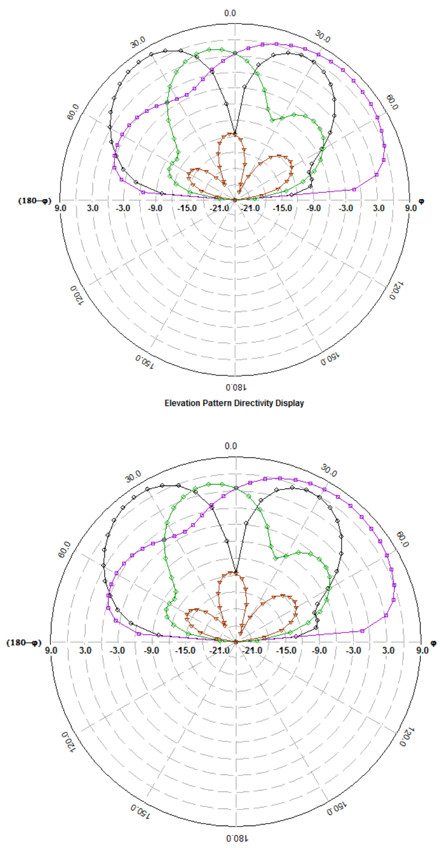


Figure 7. Elevation pattern Directivity Display at f = 7.75 and 9.4 GHz

IV. CONCLUSION

In modern communication systems multiband microstrip antenna has a special attraction. This paper deals with the design, simulation and analysis of the dual band antenna using IE3D software [4]. The analysis is done using transmission line model and cavity model. Some of the major parameters [8-11] like return loss, VSWR, gain, directivity and current distribution of the antenna are shown. In simulation the S (1, 1) has a negative value, which indicates that the losses are minimum during the transmission. As for a dual band antenna, S (1, 1) is acceptable at two frequencies, i.e. 7.75 GHz and 9.4 GHz, its value is -35 dB and -43 dB respectively. The observed VSWR at 7.75 GHz and 9.4 GHz are 1.3 and 1.2 indicating that the level of mismatch is not so high [10]. This antenna

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