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Design of Dual Frequency Stacked Patch Antenna

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Abstract— The endeavour presents a detailed explanation on stacked Microstrip circular patch antenna for dual band frequency applications. The aerial operates at L-band and S-Band at 1.36 GHz and 2.49 GHz respectively with operational bandwidth of 75.4 MHz and 85.6 MHz. The antenna has been designed and simulated on a Frame Retarded4epoxy substrate with dielectric constant of 4.4 and thickness of 0.6 mm. The design is analysed by Finite Element Method based HFSS Software (version 14.0), the simulated results shown that the proposed antenna provides appreciable performance in term of return loss and radiation pattern for dual frequency applications.

Keywords— Dual Frequency, HFSS, Microstrip Antenna, Return Loss, Stacked Patch.

I. INTRODUCTION

In recent years, the trend in commercial and government communication system has been to develop low cost, minimal weight, low profile antennas that are capable of maintaining superior performance over a large spectrum of frequencies. This technological trend has focused much effort in to the design of microstrip (Patch) antennas. With a simple geometry, patch antenna offer many advantages not commonly exhibited in other antenna configurations. In addition, once the shape and operating mode of the patch are selected, designs become very versatile in the terms of operating frequency, polarization, pattern and impedance .The variety in design that is possible with microstrip antennas probably exceeds that of any other type of antenna element.

Due to the advancements in the modern wireless communication systems the need for the dual frequency antennas has been the order of the day, Dual-frequency antennas exhibit a dual-resonant behaviour in a single radiating structure. When the system requires operation at two frequencies too far apart, dual-frequency patch antennas may avoid the use of two different antennas.

The stacked coupled patch structures have been favoured in most applications because of the ease with which the coupling coefficient can be controlled by adjusting their separation height. Their other parameters such as the size of the patches and substrate parameters can also be modified independently to facilitate the designs.

In this paper we have one such antenna which meets the demand of L-band and S-band applications like satellite based portable communication devices, especially weather radar, surface ship radar, and some communications satellites.

II. DESIGN CONSIDERATIONS

Design considerations and formulae for the Microstrip Stacked Circular Patch Antenna are as follows:

A. *Frequency of Operation*

The Satellite Communication Systems uses the L-Band & S - Band with frequency domain from 1 GHz – 2 GHz and 2 GHz – 4 GHz respectively. Subsequently the operating frequency selected for the design is 1.36 GHz and 2.94 GHz.

B. *Dielectric Constant of Substrate*

Frame Retarded 4epoxy is the dielectric material with dielectric constant of 4.4. High dielectric constant is selected since it reduces the dimensions of the antenna [1].

C. *Height of the Substrate*

As thickness of substrate increases, surface waves are induced within the substrate. Surface waves results in undesired radiation, decreases antenna efficiency and introduces spurious coupling between different circuits or Antenna elements, Hence the height of the substrate is considered to be 0.6 mm (h=0.05(λ)) [2].

D. *Length and Width of the Dielectric Substrate*

Both the length and width of the substrate are taken as λ [3].

E. *Radius of the Patch*

The radius of the patch is 27.94 mm and 13.98 mm, which are calculated using the formulae [3].

$$a = F\{1+\frac{2h}{\pi F \in_r}[\ln(\frac{\pi f}{2h})+1.7726]\}^{-1/2} \quad (1)$$

$$F = \frac{8.791\times10^9}{f_r \in_r} \quad (2)$$

$$a_l = a\{1+\frac{2h}{\pi a \in_r}[\ln(\frac{\pi a}{2h})+1.7726]\}^{1/2} \quad (3)$$

III. DESIGN OF PROPOSED ANTENNA

The above parameters are analysed and used in designing microstrip stacked patch antenna in HFSS simulator, PEC is been used as material for the patch and coaxial feed is been used for feeding the antenna, initially with the lower patch alone, the antenna is resonating at only one frequency (1.36 GHz) then the second patch is introduced above the first patch along with a FR4 substrate by varying the position of the feed and the height of the dielectric substrate optimisation has been done to achieve the dual frequency operation as shown in Fig. 1.

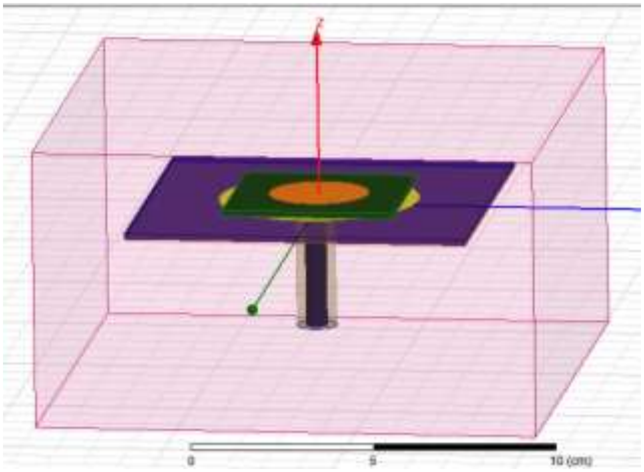

Fig. 1 Stacked Patch Antenna

IV. RESULTS

Antenna has been resonated at dual frequency of operation at 1.36 GHz and 2.94 GHz with a peak gain of 4.76 dB and 0.694 dB respectively.

A. Return Loss

Obtained return loss of -21.83 dB at 1.36 GHz and -28.36 dB at 2.94 GHz with an operational band width of 75.4 MHz and 85.6 MHz as shown in Fig. 2.

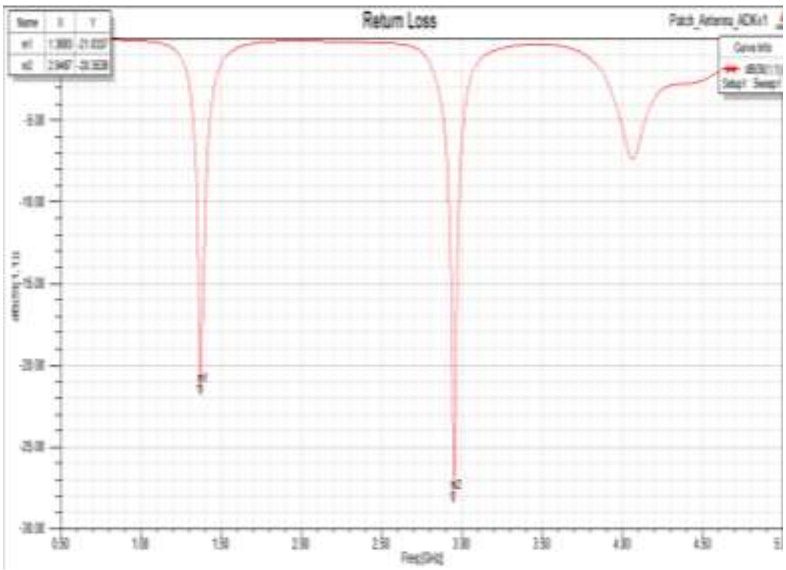

Fig. 2. Return Loss Curve

B. 3D Polar Plot for Gain

Achieved a gain of 4.76 dB at 1.36 GHz and 0.69 dB at 2.94 GHz.

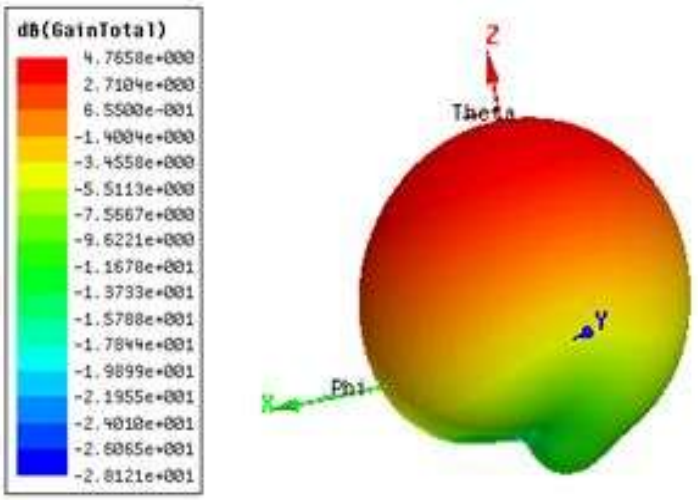

Fig. 3. 3D Polar Plot for Gain for 1.36GHz

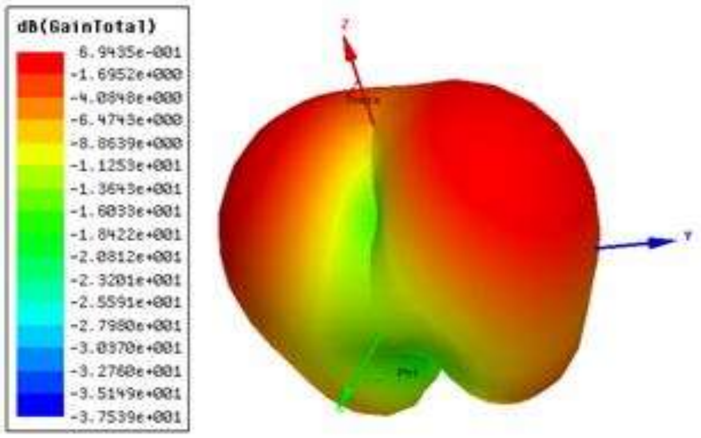

Fig.4. 3D Polar Plot for Gain for 2.34GHz

V. CONCLUSIONS

After analysis, the characteristics of the proposed antenna are given as follows, Obtained dual band at 1.36 GHz and 2.94 GHz frequencies with an operational band width of 75.4 MHz and 85.6 MHz. Achieved a gain of 4.76 dB and 0.69 dB with a return loss of -21.83 dB and 28.36 dB, so it is clear that this antenna is perfect for L-Band and S-Band applications such as Weather radar, surface ship radar, and some communications satellites. The resonance frequency and impedance matching depend on the position of coaxial feed, height between the patches and the radius of the patches.

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