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Performance Analysis of 2*2 Dual Frequency Wide Band Circular Patch Antenna Array

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Abstract: In this paper, we have proposed a dual frequency wide band circular patch antenna array of 4 elements for radar applications designed at Ka Band The antenna array simulations are carried out by using HFSS software. FR4 epoxy with dielectric constant 4.4 and thickness 0.21 mm is used as substrate. Details of the antenna array design are presented and simulation results are discussed. Antenna arrays at Ka Band are useful for many types of applications such as communication Satellites, Vehicle speed detection systems, High-resolution and close range targeting radars aboard military airplanes.

Keywords: Antenna Array, HFSS, Radar.

I. INTRODUCTION

To create a communication link Antennas are the most important components in modern communication systems. Microstrip antennas, because of their low profile, light weight and low power handling capacity are well suited for aerospace and mobile applications. In order to obtain enhanced gain and bandwidth they can be designed in a variety of shapes. The proposed model is a Dual Frequency Wide Band circular patch antenna array, with coaxial feed. It can be operated at Ka-band (26.5 to 40 GHz).

Ka-band has become the band of choice for many satellite operators due to its increasing capacity, availability and its applicability for broadband services. New Ka-band satellites are either already in orbit or are being readied for launch. It encompasses a new type of transmission and bandwidth management to provide higher quality satellite architecture, better performance and faster speed services. Microstrip Patch Antennas have been widely used in this regard.

In this paper we have one such antenna which meets the demand of satellite based portable communication devices, especially vehicle tracking, portable satellite station, weather forecasting etc.

II. DESIGN CONSIDERATIONS

Design considerations for the Microstrip Circular Patch Antenna are as follows

A. Frequency of Operation

The Satellite Communication Systems uses the Ka-Band with frequency range from 26.5GHz - 40GHz[1] hence the antenna designed must be able to operate in this frequency range. The operating frequency selected for the design is 34.0GHz.

B. Dielectric Constant of Substrate

The dielectric material selected is FR4 which has a dielectric constant of 4.4. A substrate with a high dielectric constant has been selected since it reduces the dimensions of the antenna [1].

C. Height of Dielectric 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 0.21 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 2λ [3].

E. Radius of the Patch

The radius of the patch is 1.0689mm, which is calculated using the formulae [1].

$$a = F\left\{\mathbf{1} + \frac{2h}{\pi F \varepsilon_r}\left[\ln\left(\frac{\pi F}{2h}\right) + \mathbf{1.7726}\right]\right\}^{-1/2} \qquad (1)$$

Where

$$F = \frac{8.791 \times 10^9}{f_r\sqrt{\varepsilon_r}} \qquad (2)$$

$$a_e = a\left\{\mathbf{1} + \frac{2h}{\pi a \varepsilon_r}\left[\ln\left(\frac{\pi a}{2h}\right) + \mathbf{1.7726}\right]\right\}^{1/2} \qquad (3)$$

III. DESIGN OF PROPOSED ANTENNA

The above parameters are analysed and proposed microstrip patch antenna is designed in HFSS simulator, PEC is been used as material for the patch and coaxial feed is been used for feeding the antenna proposed antenna models are as shown below.

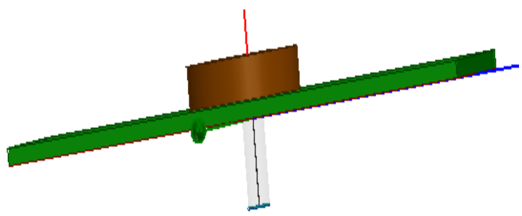

Fig.1. Dual Frequency Circular Patch Antenna

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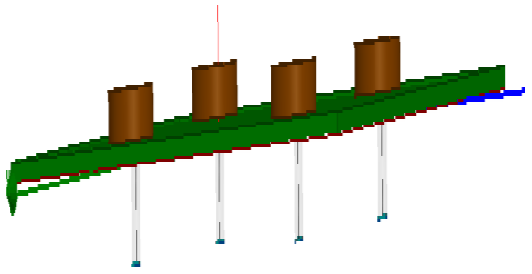

Fig.2. Dual Frequency Circular Patch Antenna Array

IV. RESULTS

Return Loss for the proposed Dual Frequency Circular Patch Antenna and Dual Frequency Circular Patch Antenna array are as shown in the figures 3 and 4.

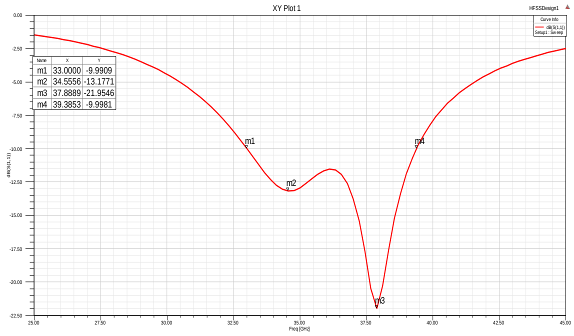

Fig.3. Return Loss for Dual Frequency Circular Patch Antenna

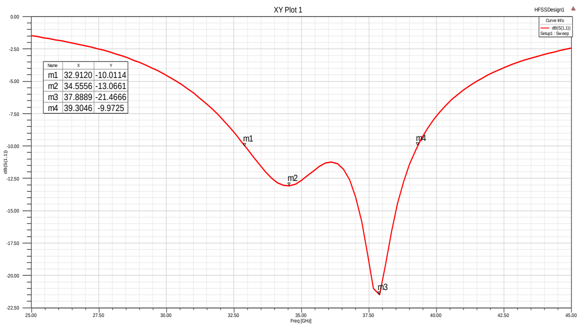

Fig.4. Return Loss for Dual Frequency Circular Patch Antenna Array

VSWR for the proposed Dual Frequency Circular Patch Antenna and Dual Frequency Circular Patch Antenna array are as shown in the figures 5 and 6.

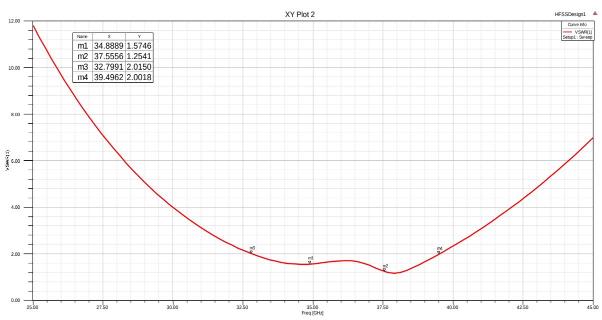

Fig.5. VSWR for Dual Frequency Circular Patch Antenna

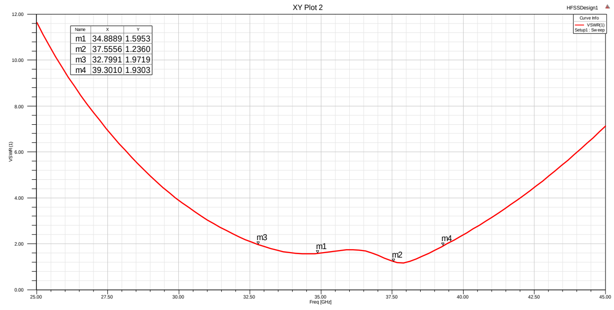

Fig.6. VSWR for Dual Frequency Circular Patch Antenna Array

Gains obtained for the proposed Dual Frequency Circular Patch Antenna and Dual Frequency Circular Patch Antenna array are as shown in the figures 7 to 10.

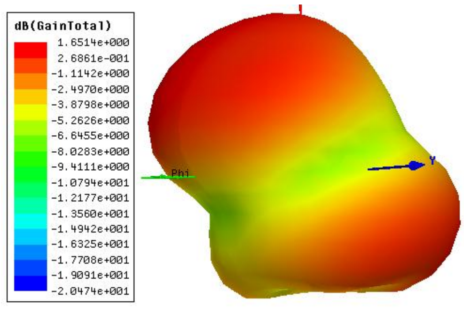

Fig.7. 3D Polar Plot at 34.55 GHz for Dual Frequency Circular Patch Antenna

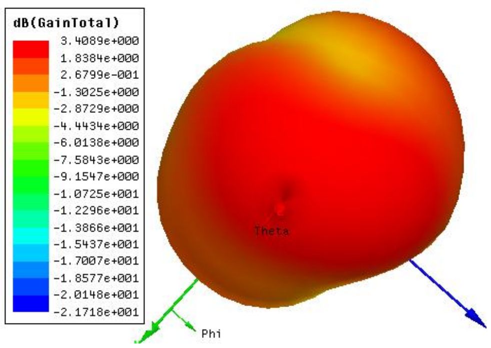

Fig.8. 3D Polar Plot at 37.88 GHz for Dual Frequency Circular Patch Antenna

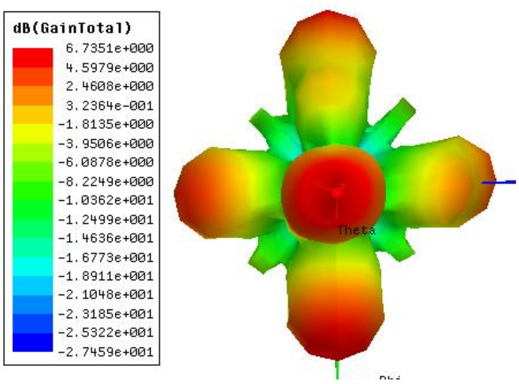

Fig.9. 3D Polar Plot at 34.55 GHz for Dual Frequency Circular Patch Antenna Array

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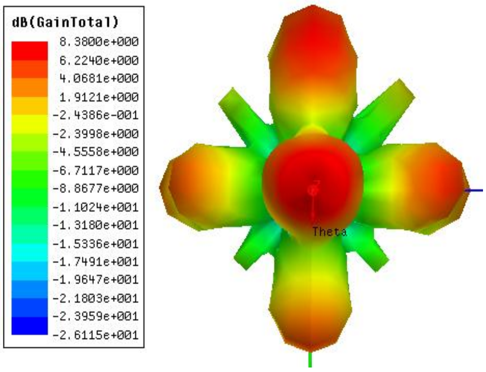

Fig.10. 3D Polar Plot at 37.88 GHz for Dual Frequency Circular Patch Antenna Array

Radiation Patterns obtained for the proposed Dual Frequency Circular Patch Antenna and Dual Frequency Circular Patch Antenna array are as shown in the figures 11 to 14.

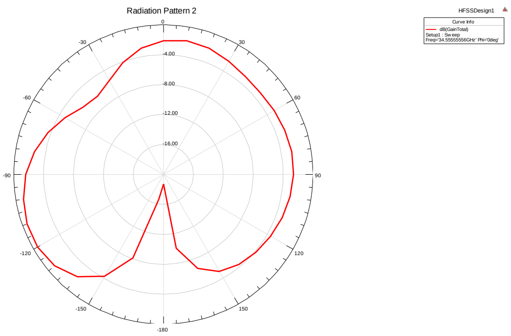

Fig.11. Radiation pattern at 34.55 GHz for Dual Frequency Circular Patch Antenna

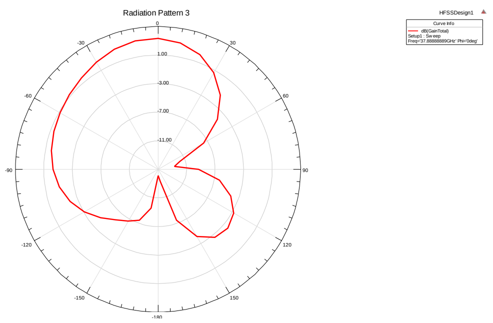

Fig.12. Radiation pattern at 37.88 GHz for Dual Frequency Circular Patch Antenna

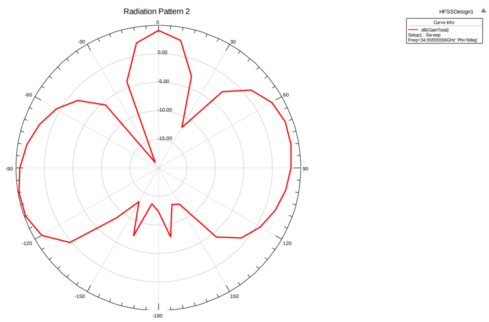

Fig.13. Radiation pattern at 34.55 GHz for Dual Frequency Circular Patch Antenna

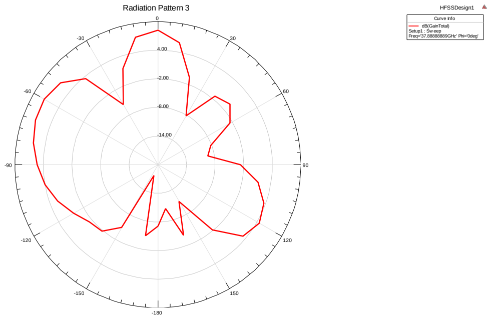

Fig.14. Radiation pattern at 37.88 GHz for Dual Frequency Circular Patch Antenna Array

V. CONCLUSION

Design of Wideband Dual Frequency Circular Patch Antenna array is done using the simulation software HFSS, achieved a good response in terms of the various antenna parameters like Return loss, VSWR, Gain and Radiation Pattern. E-Plane patterns of the Single patch antenna and 4- element array are compared and it is observed that the gain and directivity increases with increase in the number of elements.

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BIOGRAPHY

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