ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 2, Issue 5, May 2014

Performance of Feed on Dual Frequency Antenna in Ka-Band

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Abstract: This paper presents a detailed explanation on performance of feed on a Microstrip circular patch antenna for dual frequency applications. The antenna operates at Ka-Band at 34.88GHz and 37.55GHz with an operational band width of 6.51GHz (32.79GHz to 39.30GHz). The antenna has been designed and simulated on an FR4 substrate with dielectric constant of 4.4 and thickness of 0.21 mm. The design is analysed by Finite Element Method based HFSS Simulator Software (version 14.0), the simulated results shown that the proposed antenna provides good performance in term of return loss and radiation pattern for dual frequency applications.

Keywords: Microstrip antenna, Ka-Band, Dual Frequency, HFSS, Return Loss.

I. INTRODUCTION

Antennas are the most important components in modern communication systems to create a communication link. Microstrip antennas are well suited for aerospace and mobile applications because of their low profile, light weight and low power handling capacity. They can be designed in a variety of shapes in order to obtain enhanced gain and bandwidth. The proposed model is a Dual Frequency circular patch antenna, 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 satellite architecture, new transmission and bandwidth management to provide higher quality, 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].

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

where

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

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

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III. DESIGN OF PROPOSED ANTENNA

The above parameters are analysed and used in designing microstrip 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 feed position at the centre of patch, the antenna is resonating at only one frequency (32.33GHz) then by varying the position of the coaxial feed in both x and y directions with a step size of 0.05mm we are able to achieve dual frequency of operation (34.44GHz and 38.44GHz) and then by varying the height of the patch we achieved dual frequency of operation (34.44GHz and 38.44GHz) along with wide band of operational band width of 6.51GHz (32.79GHz to 39.30GHz).

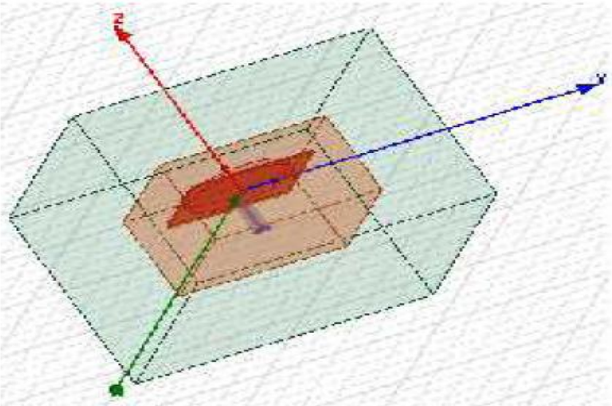

Fig. 1 Microstrip circular patch antenna

IV. RESULTS

Obtained results at various stages of designing are as follows

A. Feed at the Centre of the Patch

With feed at the centre of the patch, obtained single frequency of operation at 32.33GHz with a return loss of -12.54db and a peak gain of 0.82.

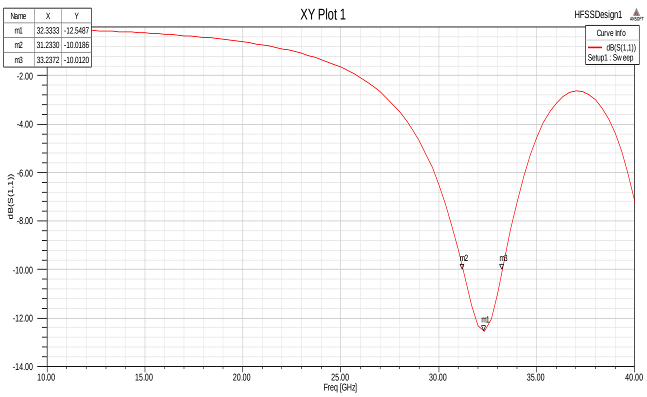

Fig. 2 Return loss with Single Frequency of Operation

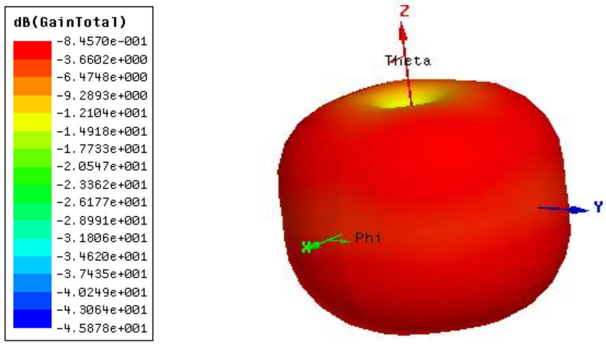

Fig. 3 3D Polar Plot

B. Feed at (x,y) = (-0.17,-0.13) mm from Centre of the Patch

With feed at (x,y) = (-0.17,-0.13) mm from the centre of the patch, obtained Dual frequency of operation at 34.44GHz and 38.44GHz with a return loss of -20.29db and a peak gain of 0.80.

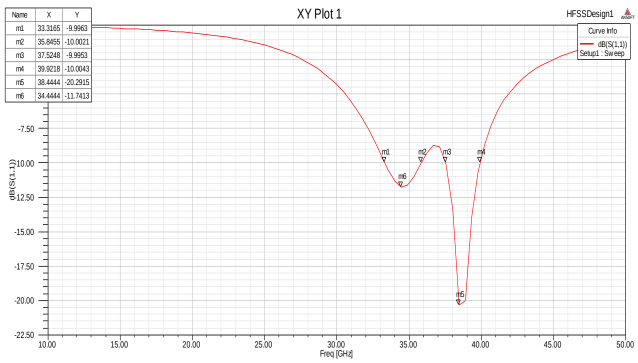

Fig. 4 Return loss with Dual Frequency of Operation

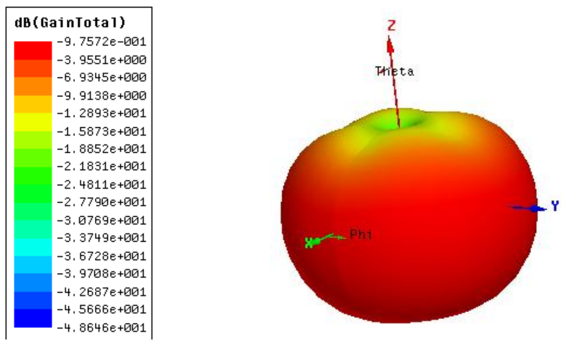

Fig. 5 3D Polar Plot

C. Feed at (x,y) = (-0.25,0.1) mm from Centre of the Patch

With feed at (x,y) = (-0.25,0.1) mm from the centre of the patch, obtained Dual frequency of operation at 34.88GHz and 37.55GHz with an operational band width of 6.51GHz (32.79GHz to 39.30GHz) with a return loss of -16.71db and a peak gain of 1.25.

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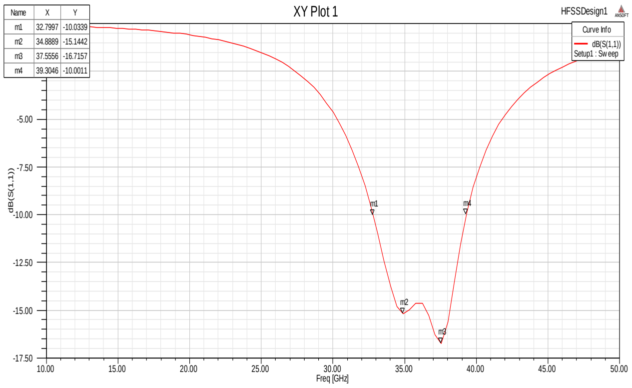

Fig. 6 Return loss with Wide Band of Operational Frequency

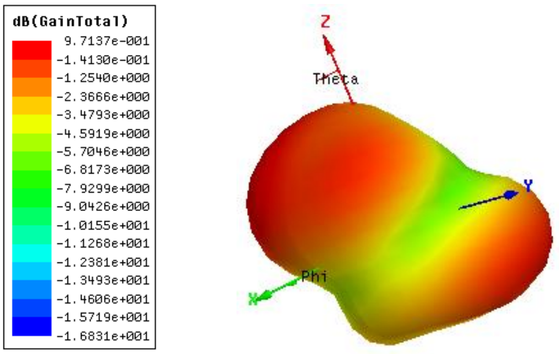

Fig. 7 3D Polar Plot

V. CONCLUSION

After analysis, the characteristics of the proposed antenna are given as follows, Obtained dual band at 34.88 GHz and 37.55 GHz frequencies with an operational band width of 6.51GHz (32.79GHz to 39.30GHz) with a gain of 1.25 and return loss of -16.71db, so it can be clearly say that this antenna is perfect for Ka-Band and Dual Band applications such as communication Satellites, Vehicle speed detection systems, High-resolution and close range targeting radars aboard military airplanes. The resonance frequency and impedance matching depend on the position of coaxial feed and height of the patch .

ACKNOWLEDGMENT

Extending our grateful thanks to the authorities of Acharya Nagarjuna University for their support and encouragement to write this paper.

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