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Shorting Pin Loaded Dual Frequency Antenna

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Abstract- This paper presents a detailed explanation on shorting pin loaded Microstrip circular patch antenna for dual frequency applications. The antenna operates at S-Band at 2.39 GHz and 3.88 GHz with operational band width of 132.4 MHz and 125.6 MHz. The antenna has been designed and simulated on an FR4 substrate with dielectric constant of 4.4 and thickness of 0.2979 cm. 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.

Key words- Microstrip antenna, Shorting Pin, S-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 loaded with shorting pin, with coaxial feed. It can be operated at S-band (2 to 4 GHz).

The S-Band spectrum has been a bone of contention between terrestrial mobile phone service providers and backers of satellite mobile services for the last few years. Terrestrial mobile phone operators have been using the S- band for 3G services. Indian Space Research Organisation (ISRO) is using it for radio networking, cyclone warning dissemination system, meteorological data dissemination and satellite mobile television transmission. Wimax service Provider use S-Band spectrum for wireless broadband technology.

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

II. DESIGN CONSIDERATIONS

Design considerations and formulas for the Micro strip Circular Patch Antenna are as follows

A. Frequency of Operation

The Satellite Communication Systems uses the S-Band with frequency range from 2 GHz – 4 GHz [1]. Hence the operating frequency selected for the design is 2.4 GHz.

B. Dielectric Constant of Substrate

The dielectric material selected is FR4 which has a dielectric constant of 4.4. High dielectric constant is 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 0.2979 cm (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. Shorting pin

The radius of the shorting pin is 0.1 cm and height is 0.2979mm. The material used for the shorting pin is PEC and it is placed in between the ground plane and the patch.

F. Radius of the Patch

The radius of the patch is 1.7492 cm, which is calculated using the formulae [1].

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

where

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

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

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 alone, the antenna is resonating at only one frequency (2.39 GHz) then the shorting pin is been placed in between the patch and ground with height equal to height of the substrate and having a radius of 0.1 cm, by varying the position of the shorting pin in both x and y directions with a step size of 0.05 mm we are able to achieve dual frequency of operation (2.39 GHz and 3.88 GHz) at the position (x,y) = (0.2,0). Material used for the shorting pin is PEC, and it is observed that by varying the position of the shorting pin with respect to the position of the coaxial feed and by varying the radius of the shorting pin we can achieve the dual frequency of operation.

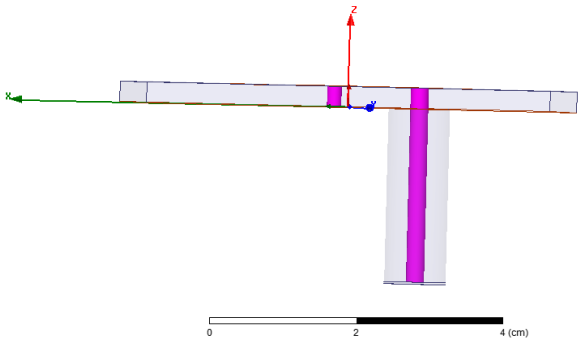

Fig. 1 Microstrip circular patch antenna

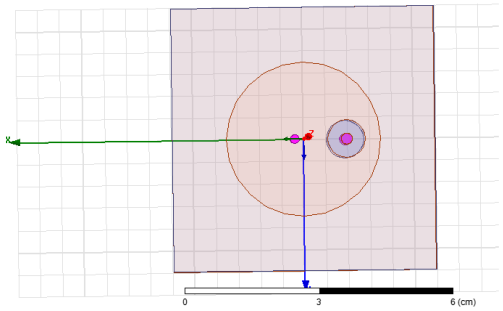

Fig. 2 Microstrip circular patch antenna

IV. RESULTS

Obtained Dual frequency of operation at 2.39 GHz and 3.88 GHz with a peak gain of 2.99 dB and peak directivity of 4.44.

A. Return Loss

Obtained return loss of -13.93 dB at 2.39 GHz and -17.52 dB at 3.88 GHz with an operational band width of 132.4 MHz and 125.6 MHz.

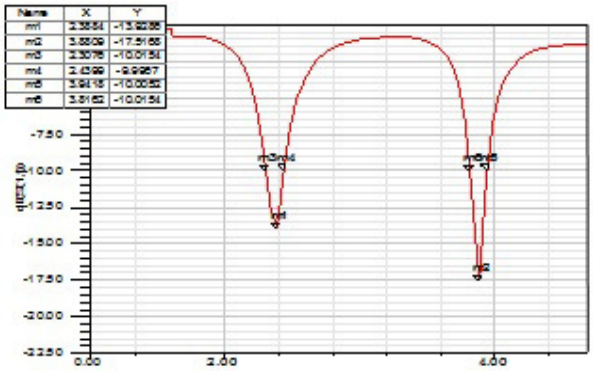

Fig. 3 Return loss

B. 3D Polar plot

Obtained 3D Polar plot is as follows

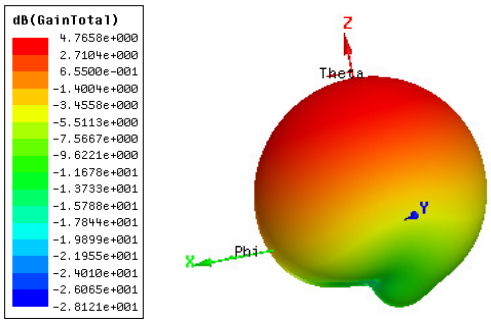

Fig. 4 3D Polar Plot

C. Radiation Pattern

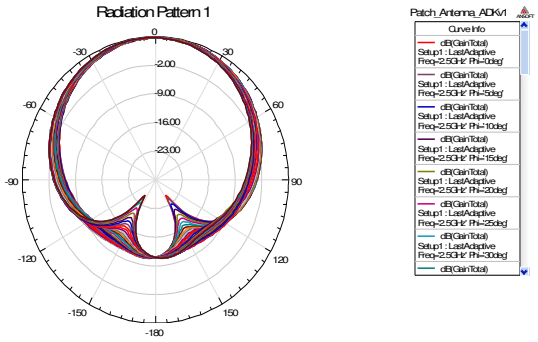

Fig. 5 Radiation Pattern

D. Peak Gain and Directivity

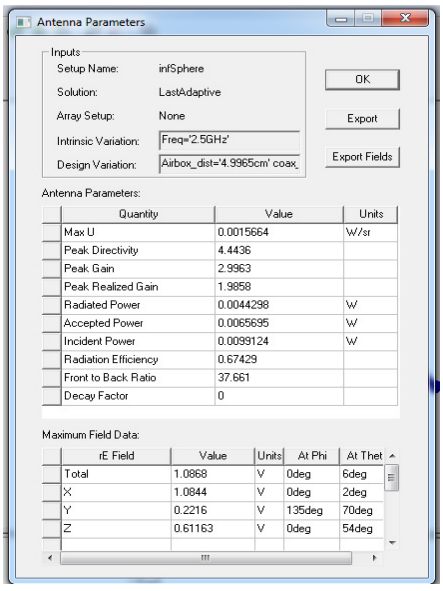

Fig. 6 *Peak Gain and Directivity*

V. CONCLUSION

After analysis, the characteristics of the proposed antenna are given as follows, Obtained dual band at 2.39 GHz and 3.88 GHz frequencies with an operational band width of 132.4 MHz and 125.6 MHz with a gain of 2.99 dB and return loss of -17.51dB, so it is clear that this antenna is perfect for S-Band and Dual 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, position of the shorting pin and its radius.

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