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Design of Dual Frequency Rectangular Patch Antenna Operating in Ku-Band

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Abstract: This paper presents a microstrip fed rectangular patch antenna to operate at Ku-band at 12.33 GHz and 15.33 GHz with an operational bandwidths of 0.7 GHz (12 to 12.7 GHz) and 0.97 GHz (14.83 to 15.8 GHz). The antenna has been designed and simulated on an FR4 substrate with dielectric constant of 4.4 and thickness of 0.157 cm.This paper also presents the detail steps of designing and simulating the rectangular patch antenna in Ku-band.The design is analysed by Finite Element Method based HFSS Simulator Software (version 14.0) by which return loss,3D polar plot,Gain of the antenna are computed.The simulated results shows that the proposed antenna provides good performance in terms of return loss and radiation pattern for dual frequency applications.

Keywords: Rectangular patch, Ku-Band, Microstrip Antenna, HFSS, Return loss, Bandwidth, Gain.

I. INTRODUCTION

Antennas are the most important components in modern communication systems to create a communication link. Microstrip antennas are widely used in wireless communication systems because they are low profile, of light weight, of low cost, of conformal design, low power handling capacity and easy to fabricate and integrate. They can be designed in a variety of shapes in order to obtain enhanced gain and bandwidth.

The implementation of the microstrip patch antenna is a milestone in wireless communication systems and is continuing to fulfil the changing demands of the new generation of antenna technology. The design of microstrip patch antenna operating in Ku band is a difficult task. Ku band is primarily used in the satellite communication most notably for fixed and broadcast services and for specific application for NASA. Ku-band is also used for satellite from remote location back to a television network studio for editing and broadcasting. Ku-band provide reliable high-speed connectivity between personal organizers and other wireless digital appliances.

Many researchers have heavy interest especially in designing Ku-band microstrip antennas and still face a major challenge to implement these applications.The proposed model is one such antenna which is a Microstrip fed rectangular patch antenna.It can be operated at Ku-Band (12-18 GHz) [1]. In addition to its operation in Ku band the proposed antenna is also a dual band antenna.Dual frequency antenna is used in applications where transmission and reception should be done using same antenna.Many dual-band antennas have been improved to face the rising demands of a modern portable wireless communication device that is capable of integrating more than one communication standard into a single system. The proposed antenna is one such with improved gain and directivity.

II. DESIGN CONSIDERATIONS

A. Frequency of Operation:

The operating frequency selected is 13.28 GHz in Ku-band. Ku-band is a portion of the EM spectrum in the microwave range of frequencies. Ku refers to "K-Under", in other words the band directly below the K-band. IEEE standard frequency range is from 12-18 GHz.

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.

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 0.157 cm.

D. Length and Width of substrate:

The length and width are chosen such that Length is 3 cm ($L > \lambda$) and width is 3 cm ($W > (\lambda/2)$).

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E. Microstrip feed position:

The position of strip feed is adjusted so as to obtain dual frequency with good return loss.

Other Antenna parameters like Width of patch (W), Length of patch (L) etc. are calculated from above equations.

$$W = \frac{v_o}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}} \quad (1)$$

$$L = \frac{v_o}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L \quad (2)$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2} \quad (3)$$

$$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)(W/h + 0.264)}{(\varepsilon_{reff} - 0.258)(W/h + 0.8)} \quad (4)$$

III. DESIGN OF PROPOSED ANTENNA

In this paper the microstrip fed rectangular patch antenna has been modelled and simulated at Ku-band. The patch(radiating part) is the dominant figure of a microstrip antenna; the other components are the substrate and ground, which are the two sides of the patch.

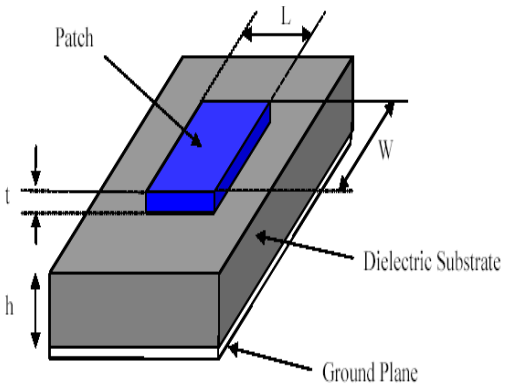

Fig. 1 Model of Microstrip antenna

The analysis of dual band antenna for 12.33 GHz and 15.33 GHz frequency and the designing has been done using HFSS Software [2]. The Proposed antenna designed is as follows

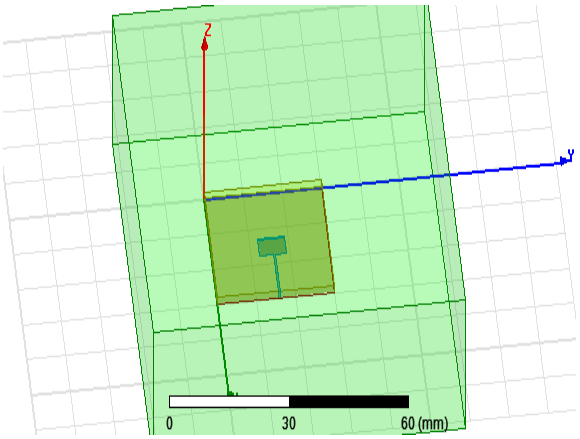

Fig. 2 Designed Microstrip antenna

IV. RESULTS

The return loss, 3D polar plot, peak gain are obtained using HFSS 14.0. The result shows that the return loss of -15.19 dB is achieved at the first resonant frequency of 12.33 GHz and -19.79 dB is obtained at the second resonant frequency of 15.33 GHz. The antenna gives a stable radiation performance with gain greater than 3 dBi (i.e. 3.45) and directivity of 4.43 over the frequency band.

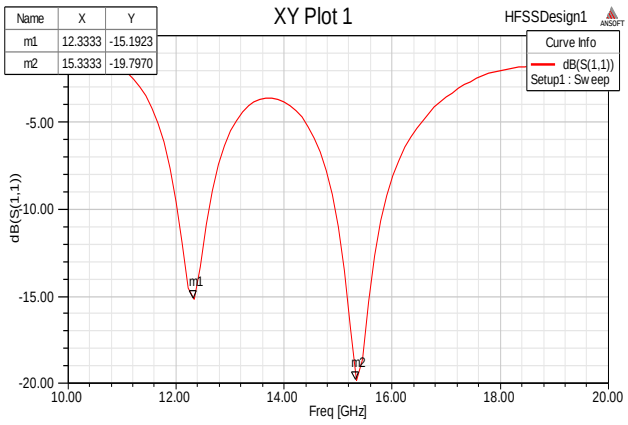

Fig. 3 Return Loss

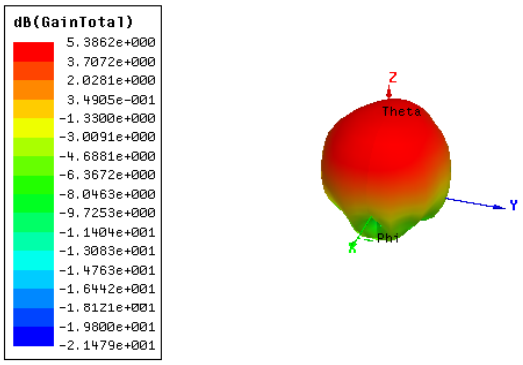

Fig. 4 3D Polar plot

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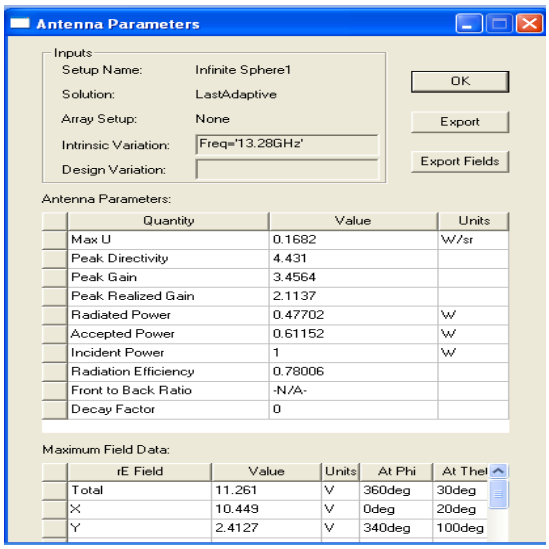

Fig. 5 Antenna Parameters

V. CONCLUSION

After analysis, the characteristics of the proposed antenna are given as follows, Obtained dual band at 12.33 GHz and 15.33 GHz frequencies with an operational band widths of 0.7 GHz (12 to 12.7 GHz) and 0.97 GHz (14.83 to 15.8 GHz) with a gain of 3.45, directivity of 4.43 and return loss of 19.79 dB and 15.19 dB. So it can be clearly say that characteristics of proposed antenna enhanced at many parameters and this antenna is perfect for applications such as radar communication, military communication. Band width is also acceptable for both bands.

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BIOGRAPHIES

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