Design and Performance Analysis of Microstrip Slot Antenna for X- Band Applications

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Abstract- In this paper, a novel slotted microstrip patch antenna for X-band applications is presented. The proposed antenna resonates at two frequencies 9.0 GHz and 10.35 GHz having return loss values of -26.85 dB and -16.13 dB respectively, with a peak gain of 6.27 dB and have a bidirectional radiation pattern. The bandwidth of the proposed design is 1.56 GHz. Two circular slots of radius 0.45 mm are cut in the radiating patch for size reduction as well as making the antenna to have multi-dimensional characteristics with improvement in antenna parameters like gain etc. The FR4 with permittivity of 4.4 is used as a substrate with dimensions of 30mm x 30mm in X and Y directions and having a thickness of 1.6 mm. The microstrip feed of size 5mm x 2mm is used in the proposed design.The proposed antenna is simulated by using Ansoft HFSS software and results obtained for the proposed design are optimized,and they exhibit good radiation characteristics within the X-band frequency range.

Keywords- *Microstrip; Bandwidth; Gain; X- band; Slots.*

I. INTRODUCTION

An antenna is a vital component of modern wireless communication systems. The success of communication systems is dependent on the characteristics of an antenna that it should be of low profile, compact size and have good radiation properties [1-5]. X-band is the frequency band in the microwave frequency region of the radio spectrum. The X-band finds its application in radar engineering, satellite communication, space-crafts, wireless computer networks,etc. The frequency range of the X-band is 7.0 GHz to 11.2 GHz in radar engineering, radars which operate in this range are generally used as police radars for measuring the speed of the vehicles, for military applications, for navigation purposes and in determining the weather forecast. IEEE specified frequency range of X-band is 8.0 GHz to 12.0 GHz [6-11]. So, in this paper, a novel slotted microstrip patch antenna is presented.
The proposed antenna resonates at two frequencies 9.0 GHz and 10.35 GHz and the total bandwidth achieved is 1.56 GHz with a peak gain of about 6.27 dB. Also, the radiation properties of the proposed antenna are analyzed using HFSS software,andthe radiation characteristics of antenna show that it can be used for various X band applications.

II. ANTENNA DESIGN

In this paper, a slotted microstrip patch antenna is proposed. The FR4 is having the permittivity of 4.4 with a size of $30\times30\times1.6mm^3$ is used as a substrate in the proposed design. The radiating patch has dimensions of $20\times20mm^2$ along X and Y directions. In the radiating patch, two circular slots of 0.45 mm radius are cut at the top surface to make the proposed antenna have multi-frequency characteristics also to increase the antenna parameters like gain, bandwidth,etc. A rectangular microstrip feed of length 5mm and width 2mm is used in this proposed design.
The proposed design is simulated using HFSS software. Table-1 presents the detailed dimensions of the proposed antenna.

Table-1: Proposed Antenna Dimensions

Parameter (s)	Proposed Design (mm)
Length of Substrate	30
Width of Substrate	30
Length of Ground Plane	30
Width of Ground Plane	30
Thickness of Substrate	1.6
Length of Microstrip Line	5.0
Width of Microstrip Line	2.0

Fig.1: (a) and (b) represents the structure of the top view and side view of the proposed antenna.

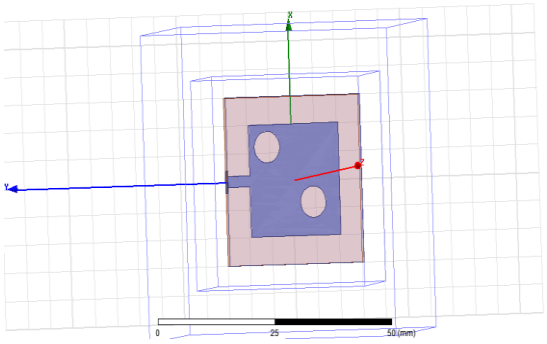

Fig.2: (a): Top view of proposed antenna

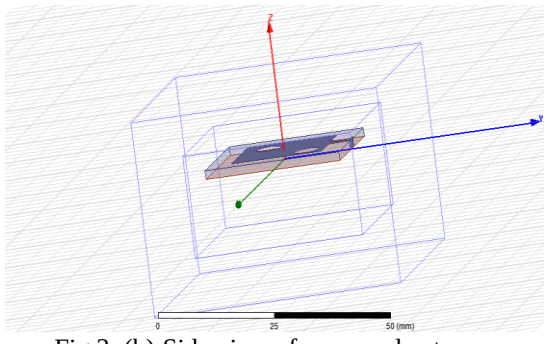

Fig.3: (b):Side view of proposed antenna

III. RESULTS AND DISCUSSION

The proposed design is simulated using HFSS software,and simulations results show that the proposed antenna can be used for X-band applications. The proposed antenna resonates at two resonating frequencies 9.0 GHz and 10.35 GHz. The simulated results of the proposed antenna are presented as follows:

i) Return Loss and Bandwidth

Figure-2 shows the return loss (S_{11}) values at two resonating frequencies 9.0 GHz and 10.35 GHz are -26.85 dB and -16.13 dB respectively. The bandwidth as calculated from return loss versus frequency plot, for the proposed slotted patch antenna is 1.56 GHz.

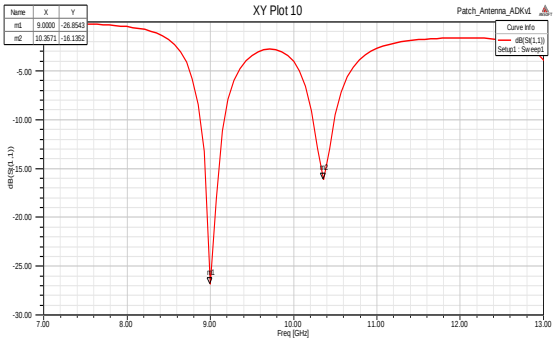

Fig.4: Return Loss (S_{11} parameters) Plot

ii) Voltage Standing Wave Ratio (VSWR)

Figure-3 represents the VSWR plot of the proposed design. The VSWR values at the above mentioned two resonating frequencies are 0.78 dB and 2.73 dB respectively.

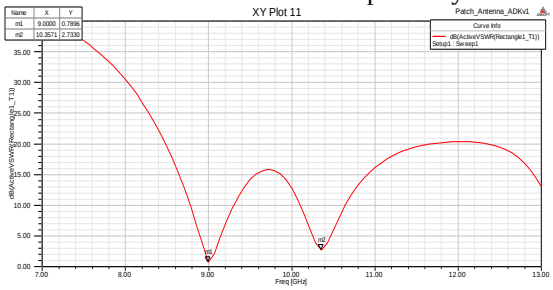

Fig.5: VSWR Plot

iii) Gain

Figure-4 represents the 3D Gain plot of the proposed design. From the plot, it can be observed that the peak gain of the presented antenna is 6.27 dB. The gain of the antenna in a particular direction is more as compared to the isotropic antenna radiating in all direction is more as compared which is very useful for various applications in X-Band providing better performance.

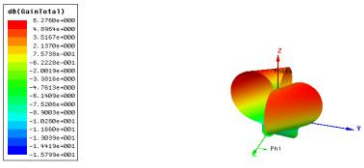

Fig.6: D Gain Plot

iv) Radiation pattern

From polar plot view of the pattern, as shown in Figure-5, it can be seen that at resonant frequencies radiation patternobtained is Bi-directional which is required for different X-band applications.

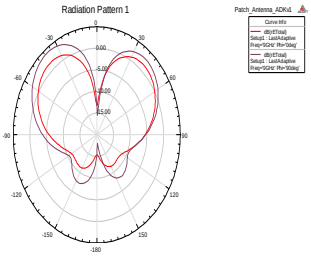

Fig.7: D Radiation Pattern

IV. CONCLUSION AND FUTURE SCOPE

Microstrip patch antennas are preferred for various wireless communication applications as it has multiple advantages like the low profile, less weight, conformal design, low cost, good radiation properties,etc. In this paper, a slotted micro strip patch antenna is designed for X-band applications. The design of the antenna is analyzed and its different parameters like gain, radiation pattern, VSWR and return loss are studied, the number of frequency bands can be further increased by proper slotting and adjusting the design parameters.Also, the use of Metamaterials in antenna designing can be done for further improvement in antenna parameters.

V. REFERENCES

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