iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** VII **Month of publication:** July 2015

DOI:

www.ijraset.com
IC Value: 13.98
Volume 3 Issue VII, July 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Analysis of Multiband S-Shaped Microstrip Antenna for Wireless Communication

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Abstract—In this research paper a S-Shaped multi frequency antenna is designed. The S-Shaped patch is obtained from conventional rectangular patch by using a rectangular slot. The antenna is excited by the use of simple probe feed. This antenna has a very simple and compact structure and thus is easy to be fabricated. The proposed antenna is operating at 1.7 GHz, 3.1 GHz, 4.15 GHz and 4.9 GHz .The design frequency of antenna is 2.05 GHz. Zeland IE3D software is used for simulation of proposed design .

Keywords— S-Shaped, Patch antenna, VSWR, Gain, Multiband

I. INTRODUCTION

In modern era, a microstrip antenna is very extensively used as it has many qualities which put it above other type of antennas , in the preference list for use. Those qualities are that, a microstrip patch antenna has a very small size, light weight, easy to fabricate, low cost. Due to these qualities, it has an edge over other type of antennas. The microstrip patch antenna has a radiating patch, a dielectric substrate and a ground plane. The patch is made up of a conducting material. The reason due to which microstrip patch antenna radiate is the presence of fringing fields between the patch edge and the ground plane. Different results are obtained after simulating the result, which eventually helps to find gain, directivity, antenna efficiency, bandwidth.

Microstrip antenna is generally used for many wireless applications due to light weight and patch can be of any shape. Patch is generally made of material such as copper or gold. In radar and satellite communication, it is necessary to design antennas with very high directive characteristics to meet the demand of long distance communication. They have the capability to operate in dual and triple band frequency operations . The patches are the basic and most commonly used Microstrip antennas. These patches are used for the simplest and the most demanding applications.

An antenna is the most important element of any wireless communication. The S -shaped Multiband Microstrip Patch antenna is simulated and analyzed using IE3D. This antenna is designed for various multiple applications such as Bluetooth, Medical Application and ISM Application, in the operating range 1-5 GHz. A compact analysis and design of S-shaped Microstrip patch antenna suited for Wi-max application is simulated over IE3D software. The obtained gain and bandwidth is best suited for Wi-max application. A wideband S-shape microstrip patch antenna is designed. The bandwidth is further increased by introducing PBG structure. The antenna designed by this method has low volume and low profile configuration, easily mounted, low fabrication cost and light weight. This antenna is best suited for S-band communication. The study of microstrip patch antennas has made great progress nowadays. The microstrip patch antennas can provide dual and circular polarizations, dual frequency operation, frequency agility, broad band-width, feed line flexibility, beam scanning omnidirectional patterning. In this paper the microstrip antenna, feeding technique and results obtained from a microstrip patch antenna are discussed in detailed form. The S-shaped Microstrip Patch Antenna is used in place of simple rectangular antenna because the surface area of former is much less than that of later, which eventually leads to better results and desired graphs.

II. FEEDING TECHNIQUES

Their are four popular feeding techniques, i.e Coaxial probe feed, Microstrip line, Aperture coupling and Proximity coupling. Here in this paper, Coaxial Probe feed is used. It is a feeding method in which inner conductor of the coaxial is attached to the radiation patch of the antenna, while the outer conductor is connected to the ground plane. This type of feeding is preferred because it is easy to fabricate, easy to match. In the absence of a good feeding, the antenna will not show the desired results, and it’s efficiency will also be not good.

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III. ANTENNA DESIGN

The figure shows the geometry of the S shaped microstrip patch antenna. To get a S shaped antenna , first of all a microstrip antenna of rectangular shape is designed according to the dimensions , which are given for length and width then S-shaped antenna's boundary's are drawn , and then it is cut down by the boundary of the proposed s shaped antenna , whose boundaries have been earlier drawn by us , in order to get the desired shaped antenna . The material used for antenna comprise of copper patch and FR4 epoxy substrate.

The dimensions of the ground plane are 35mm*40mm . A single-patch broadband microstrip S-shaped patch antenna fed by a coaxial probe feeding is then simulated and designed using IE3D software. This antenna is operating at centre frequency of 2.05 GHz.

IV. DESIGN SPECIFICATIONS

Length of Rectangular Patch (L)- 35 mm
Width of Rectangular Patch (W)- 40 mm
Substrate's Thickness -1.6mm
Dielectric Constant -4.3
Feed Point Location - (8.6,10)

Step 1: Calculation of the Width (W): The width of the Microstrip patch antenna is given by

$$W = \frac{c}{2 f_0 \sqrt{\frac{(\varepsilon_r + 1)}{2}}} \qquad \text{eq.1}$$

Step 2: Calculation of Effective dielectric constant (ε_{reff}): $\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}}$ eq.2

Step 3: Calculation of the Effective length (L_{eff}):

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{eff}}} \qquad \text{eq.3}$$

Step 4: Calculation of the length extension (ΔL):

$$\Delta L = 0.412h \frac{(\varepsilon_{eff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{eff} - 0.258)\left(\frac{W}{h} + 0.8\right)} \qquad \text{eq.4}$$

Step 5: Calculation of actual length of patch (L):

$$L = L_{eff} - 2\Delta L \qquad \text{eq.5}$$

Step 6: Calculation of the ground plane dimensions (Lg and Wg):

$$L_g = 6h + L$$

$$W_g = 6h + W \qquad \text{eq.5 \&6}$$

Where all the symbols are used in their general meaning

Volume 3 Issue VII, July 2015
ISSN: 2321-9653

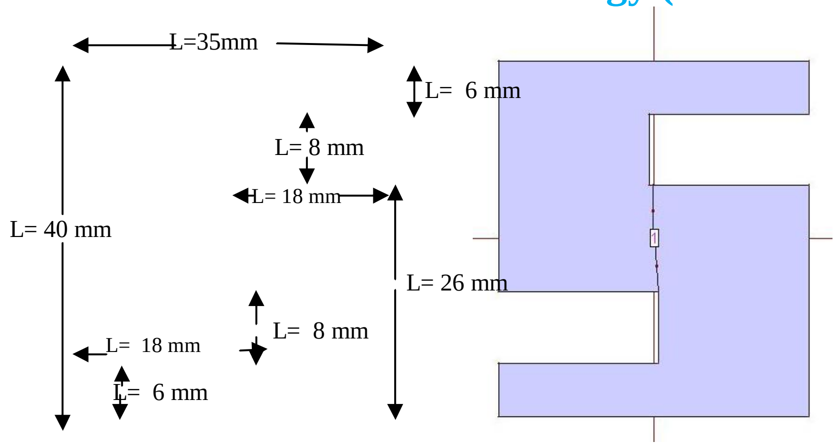


Fig.1. Geometry of S-Shaped Microstrip Antenna

V. SIMULATION RESULTS AND DISCUSSION

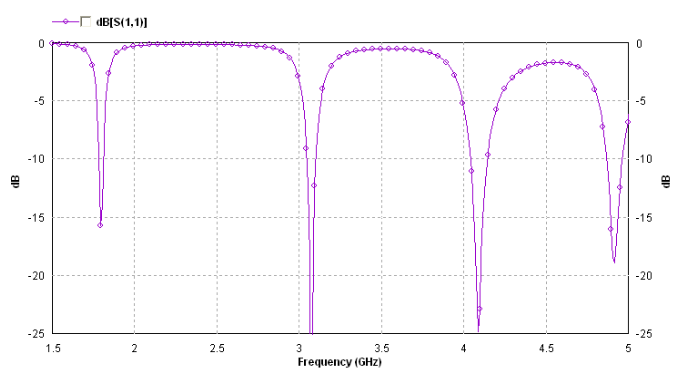


Fig. 2. S Parameter vs Frequency Curve

The return loss of the design shows that it has four resonance within the frequency band under observation. The value of first resonance is -16 dB at 1.85 GHz, second resonance is -25 dB at 3.1 GHz , -24 dB at 4.15 GHz and -18.7 dB at 4.9 GHz. Since the antenna is designed at 2.05 GHz and the first fundamental resonance is shifted towards left, therefore the antenna miniaturization is achieved by using a S-shaped antenna rather than a conventional rectangular patch.

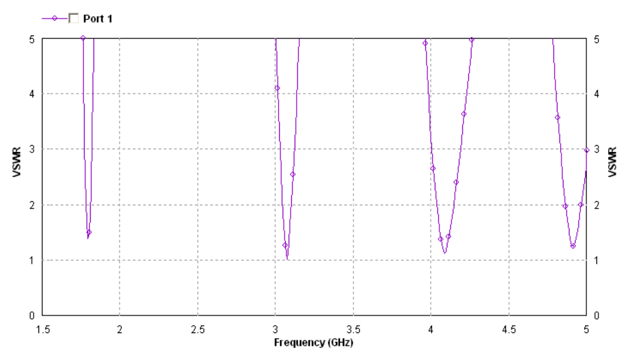
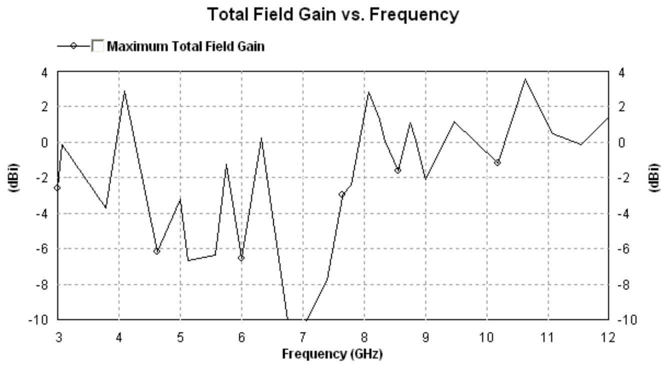


Fig. 3- VSWR vs Frequency Curve

The VSWR of the design shows that it has four resonance within the frequency band under observation. The value of first resonance is -1.4 dB at 1.7 GHz , second resonance is -1 dB at 3.1 GHz , third resonance at -1.1 dB at 4.15 GHz and fourth resonance at –1.2 dB at 4.9 GHz .



Fig, 4 – Gain vs Frequency Curve

In the graph representing Gain vs Frequency , we analyse that the maximum gain is obtained as 3.9 dB at 10.6 GHz .

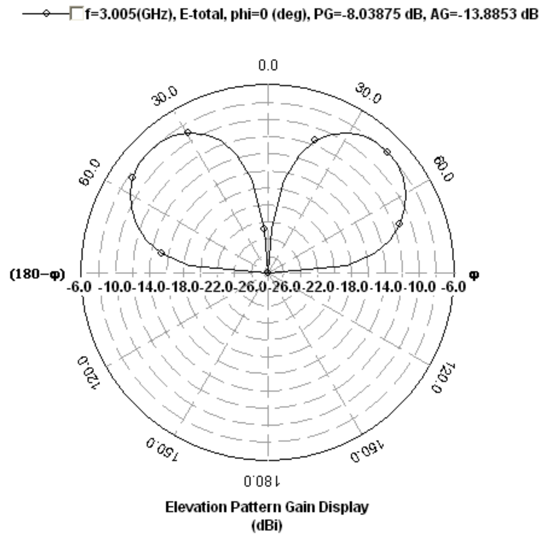


Fig. 5 – Radiation Pattern of the Antenna

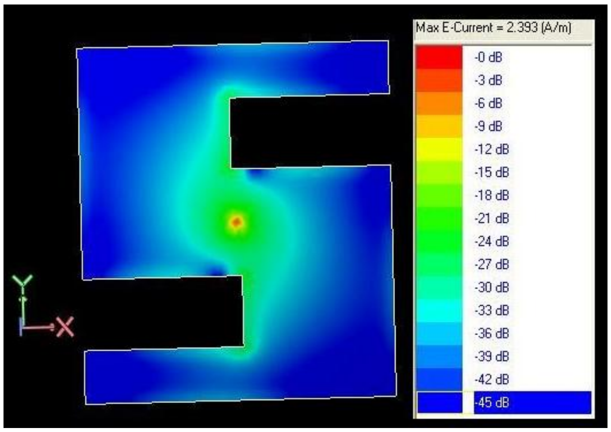


Fig. 6 – Current distribution on the Antenna

VI. CONCLUSION

The proposed antenna is operating at 1.7 GHz, 3.1 GHz, 4.15 GHz and 4.9 GHz .The design frequency of antenna is 2.05 GHz in the frequency range 1.5 GHz to 5 GHz. The results which we get after simulation tends to show that this antenna is most effective

for S Band. The antenna gives best results on being applied to devices, operating at 2.05 GHz.
The proposed antenna can be used for Wireless Communication.

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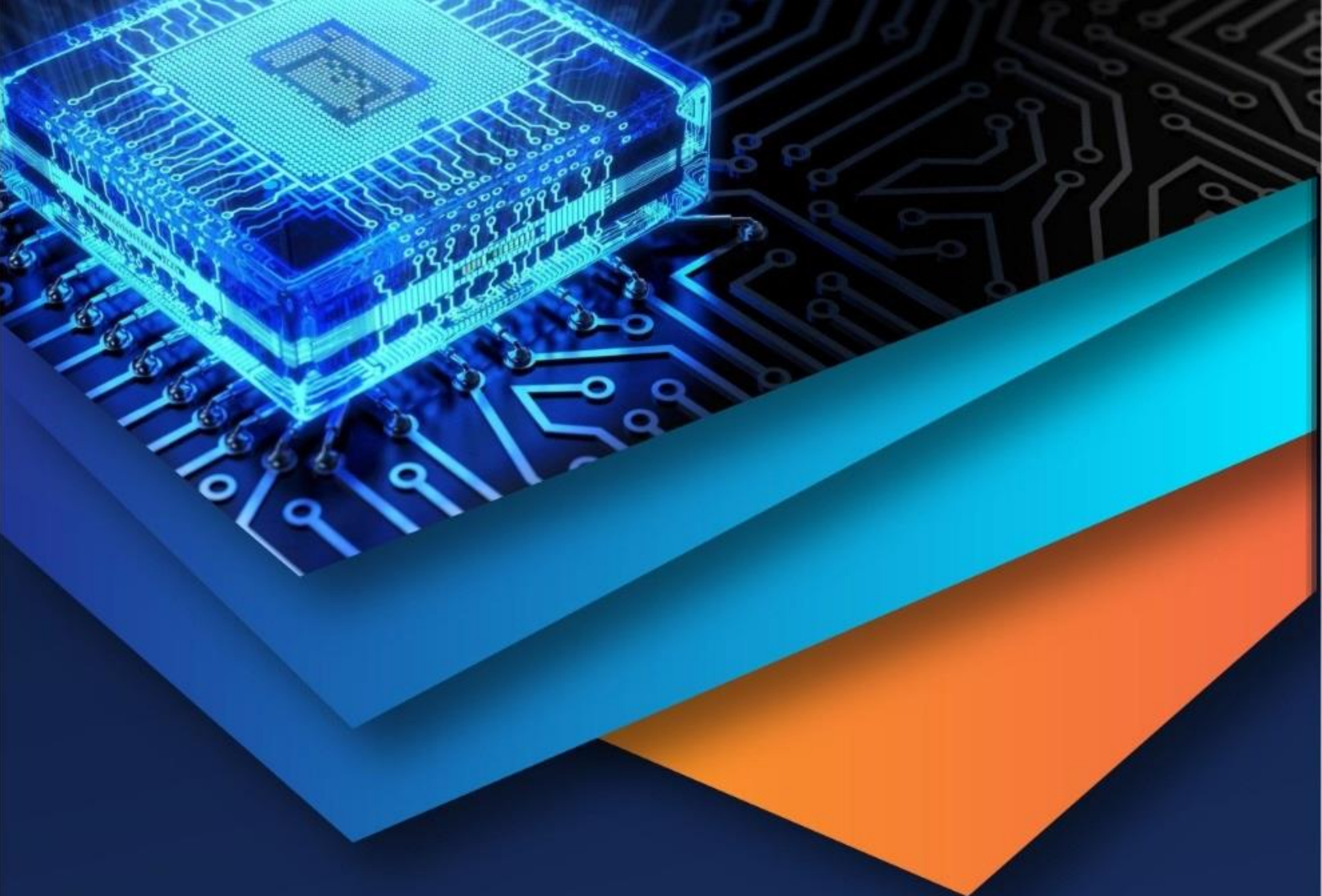

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