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PROPOSED A COMPACT MULTIBAND AND BROADBAND RECTANGULAR MICROSTRIP PATCH ANTENNA FOR C-BAND AND X-BAND

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ABSTRACT

In this communication two proposed antenna described one for broadband at 6.71445GHz to 11.9362GHz with finite ground plane. The antenna designed with 11.4051mm× 8.388 mm radiating copper patch with ground plane design with 21.0051mm x17. 988mm. And this Compact broadband rectangular shape microstrip patch antenna is designed and analyzed for the return loss of -20.08 dB is achieved at the resonant frequency of 7.941GHz, From Antenna2-it is observed that, antenna for multiband at different frequency. The primary radiating elements are Simple Rectangular Microstrip Patch Antenna in upper side with probe feed and use finite ground plane are two parallel crossed printed slot for three different frequency applications which is smaller in size compared to other available multiband antennas. From the result, it is observed that, the return loss of -16.97 dB is achieved at the first resonant frequency of 4.853GHz, -10.30dB at the second resonant frequency of 8.382GHz, -10.73 dB at the third resonant frequency of 9.265GHz, -17.38 dB at the fourth resonant frequency of 10.15GHz and -12.37 dB at the fifth resonant frequency of 11.91GHz. This broadband and multi-band highly efficient antenna for use in C-Band, and X-Band.

Indexing terms/Keywords

Rectangular Patch Antenna, Finite Ground Plane, broadband, Multiband, C-band Application and X-band Application, IE3D Software, Impedance Matching.

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1. INTRODUCTION

Wireless technology is one of the main keyword of research in the whole world of communication systems recent years and a study of communication systems is incomplete without an understanding of the operation of trasmitts and receives electromagnetic waves like as antennas. [4]. Microstrip patch antennas have become the most favourite choice of antenna designers because of advantages such as, light weight, easy fabrication, easy integration with circuits and low profile. Intensive research is going on to develop bandwidth enhancement techniques by keeping its compact size small. The IEEE C-band and X-band is a portion of the electromagnetic spectrum in the microwave range of frequencies ranging from 4.1 to 8.0 GHz. And 8.1 to12 GHz.

These frequency ranges that are used for many satellite communications, some Wi-Fi devices, some cordless telephones, and some weather radar systems. In the satelite communication is used The C-band is primarily in level, whether for full-time satellite Television networks although subscription programming also exist. This use contrasts with direct broadcast satellite, which is a completely closed system used to deliver subscription programming to small satellite dishes that are connected with proprietary receiving equipment. In recent years, demand for small antennas for wireless communication has increased the interest of research work on the compact microstrip antenna design among for satellite Communication and Radar Engineers. Nowadays, in radar and satellite communication applications, microstrip patch antennas are very popular due to their low profile, mechanically robust, relatively compact and light and the possibility of Multiband frequency operation. Increasing progress in communication system increases the demand of compact, cost effective and easily fabricated antennas. So, this requirement of present time is full-filled by the invention of patch antenna [1].

Recently, multiband patch antennas have been investigated because of exposure of many wireless communication services such as GSM, Satellite Communication, CDMA and PCS [2, 3]. The Microstrip patch antenna can be fed by various techniques which are Probe feed, microstrip line feed, proximity coupled feed and aperture/slot-coupled feed. Among all the advantages, there are a few drawbacks of using patch antenna which is low gain, narrow bandwidth, high ohmic losses and low efficiency. A wideband microstrip patch antenna which also allowed multiband properties by designing a Two Crossed Slot on the finite Ground Plane and Impedance Matching to the Single Stub was presented in this Paper. This technique gives better efficiency and gain, operating at different bands which are 4.85 GHz, 8.382GHz, 9.265 GHz, 10.15GHz, and 11.91GHz, respectively. According to the presented results, it includes two satellite communication bands which are C and X-band. These bands are also widely used in satellite and radar communication.

Microstrip antennas for use as a low profile flush mounted antennas on rockets and missiles showed that this was a practical concept for use in many antenna system problems. Various mathematical models were developed for this antenna and its applications were extended to many other fields. Technology has been developing day by day where satellite communication is becoming a daily part of our life. As the technological devices are getting smaller demand for multiband operating antennas are growing faster to the consumers.

2. DESIGN METHODOLOGY AND SIMULATION OF PROPOSED ANTENNA STRUCTURE

The material with dielectric constant 4.4 (FR4 Epoxy) is used as a backplane conductor to form Microstrip antenna. The configuration of the conventional printed antenna is shown in Figure 1 with L=8. 388 mm, W=11. 4051 mm, substrate thickness h = 1.6 mm, dielectric constant εr = 4.4. The coaxial probe - feed is located at y=W/2 =11. 4051/2=5.70255mm and x=$\frac{L}{2\sqrt{\epsilon_r}}$ =2mm and Ground Plane Design Lg=6h+L=6x1. 6+8.388=17.988mm, Wg=6h+W=6x1. 6+11.4051=21.0051mm.

The heart of a microstrip patch antenna is the upper conductor. The patch of finite dimensions. The patch can be considered to be an open-ended transmission line of length and width. The amplitude of surface currents becomes significant when the signal frequency is close to resonance by taking only the fundamental mode into account. The resonant frequency can be calculated by

$$f_o = \frac{c}{2(L + 2\Delta L)\sqrt{\varepsilon_{reff}}}$$

Where ΔL is the equivalent length extension that financial records for the fringing fields at the two open ends and ε_{reff} Is the effective relative permittivity. A microstrip structure is not homogeneous because the electromagnetic field extends over the two media air and dielectric. Therefore wave propagation cannot be TEM. Since wave in two media travels with different velocities and the boundary conditions force nonzero transverse electric or magnetic components.

RMPA parametric analysis

Width of metallic patch (W)

$$W = \frac{1}{2f_r\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon_r + 1}} = \frac{C}{2f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

Where,

c = free space velocity of light

ε_r= Dielectric constant of substrate

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Effective dielectric constant is calculated from:

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(\frac{1}{\sqrt{1 + \frac{12h}{w}}}\right)$$

Length of metallic patch (L) L = Leff - 2ΔL,

$$\text{Where } Leff = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}}$$

Calculation of Length Extension

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{eff} + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\varepsilon_{eff} - 0.258)\left(\frac{w}{h} + 0.8\right)}$$

If V_i is the amplitude of the incident wave and V_r that of the reflected wave, then the return loss can be expressed in terms of the reflection coefficient r as:

$$R_L = -20\log|\Gamma|,$$

and the reflection coefficient r can be expressed as:

$$\Gamma = \frac{V_r}{V_i}$$

For an antenna to radiate effectively, the return loss should be less than −10dB.

Impedance Matching Analysis: Impedance Matching was originally developed for electrical power, but can be applied to any other field where a form of energy is transferred between a source and a load. Impedance Matching issues can be analysed as trajectories on the Smith Chart, where the addition of a series or shunt component moves the total impedance along constant impedance, admittance, or resistance circles. If the task is to match the specific impedance to a reference impedance (generally to 50 Ω), then the target of the impedance matching is to arrive at the centre of the Smith Chart by moving along the arcs from the initial point. If the task is to provide impedance matching to impedance other than the reference impedance, then the end point of the matching trajectory must be the conjugate of the target impedance. Compact Multiband Micro strip Antenna Smith Chart Shown in below.

The closer an Impedance Matching trajectory comes to the edge of the Smith Chart, the narrower the bandwidth. Maximum bandwidth for a given matching network can be obtained by keeping the trajectories short, well away from the edges of the Smith Chart, and as close as possible to the real axis.

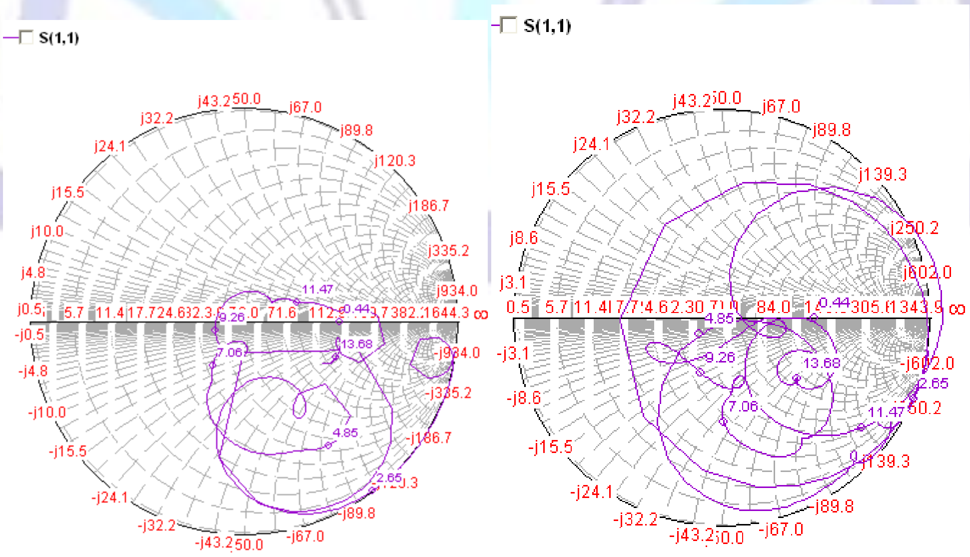

Figure1. Smith Chart Antenna 1 and Antenna 2

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3. COMPACT RECTANGULAR MICROSTRIP ANTENNA WITH AND WITHOUT MODIFIED GROUND PLANE

3.1 Analysis of Antenna 1.

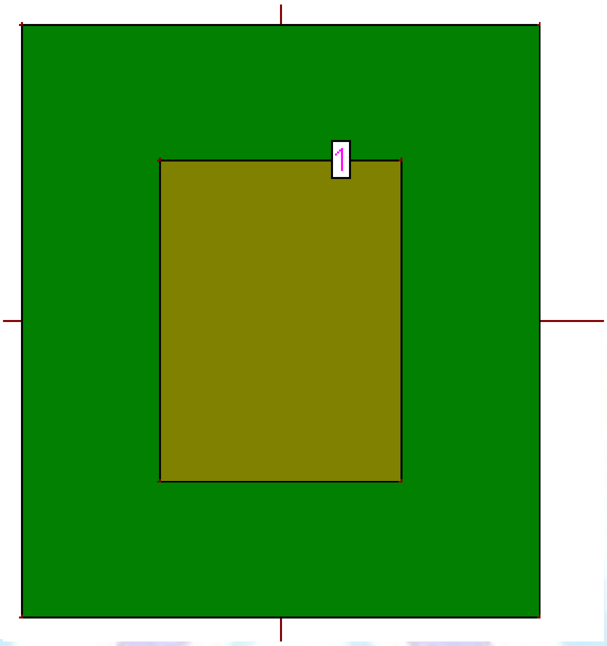

Figure 2. Upper Layer and Ground Layer Antenna 1

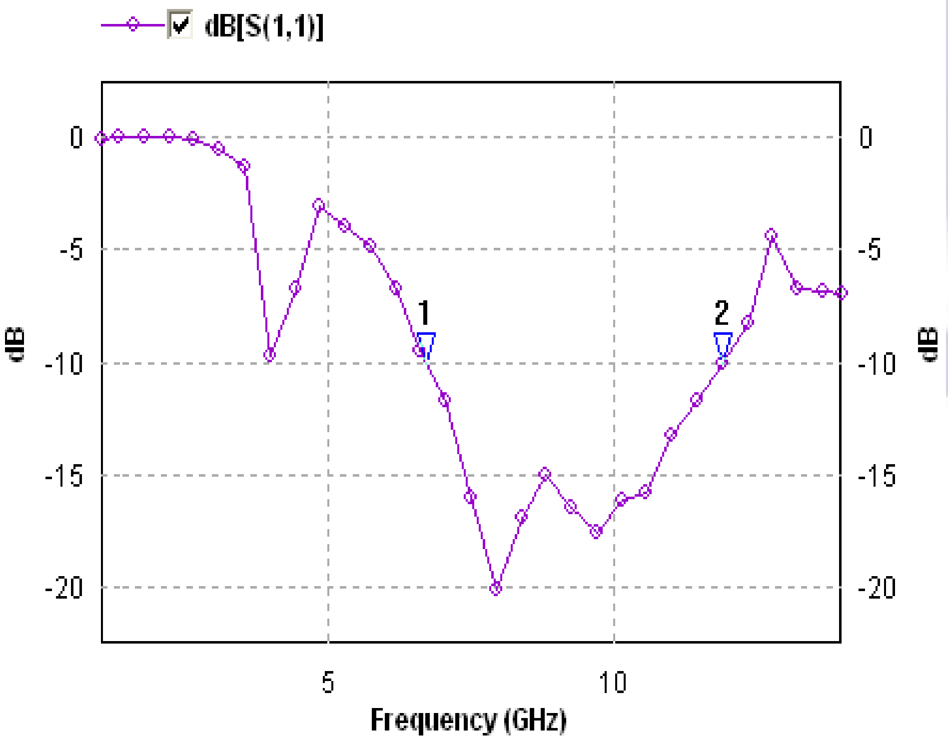

Figure 3. Return Loss of Broadband Multiband Antenna

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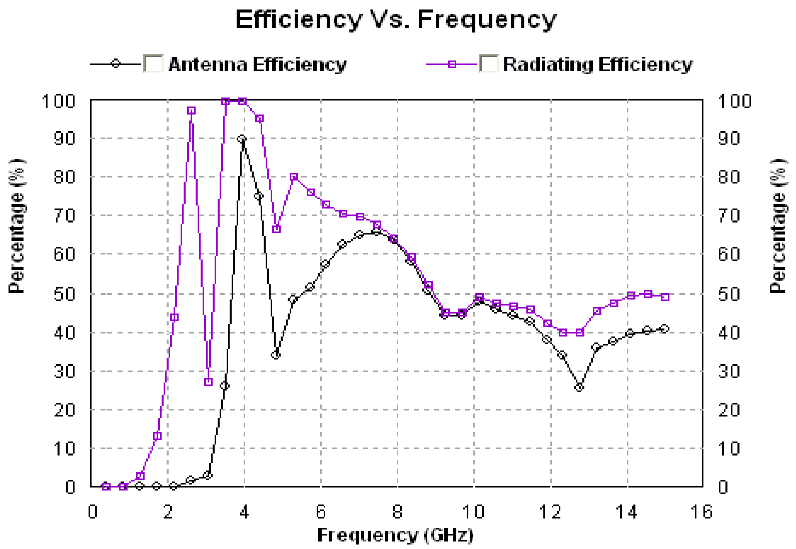

Figure 4. Graph of Axial Ratio Vs. Frequency of Multiband Antenna

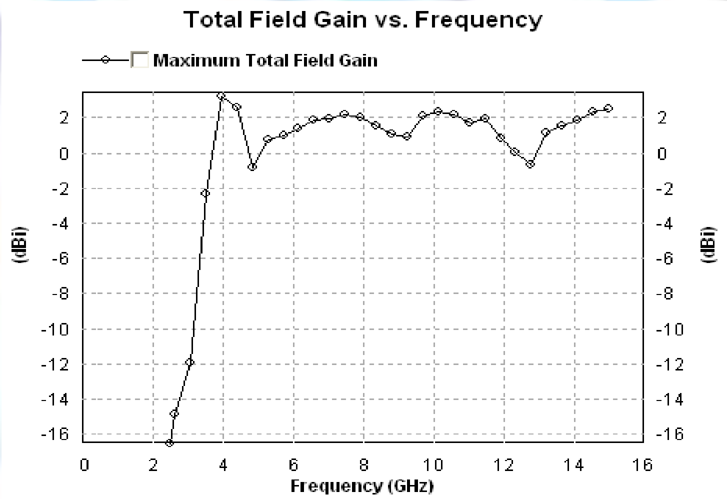

Figure 5. Graph of Efficiency Vs. Frequency of Multiband Antenna

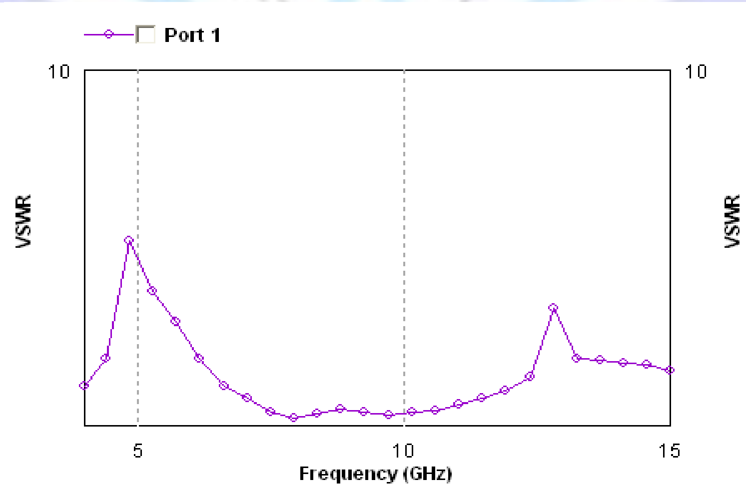

Figure 6. Graph of VSWR of Multiband Antenna

3.2 Analysis of Antenna 2.

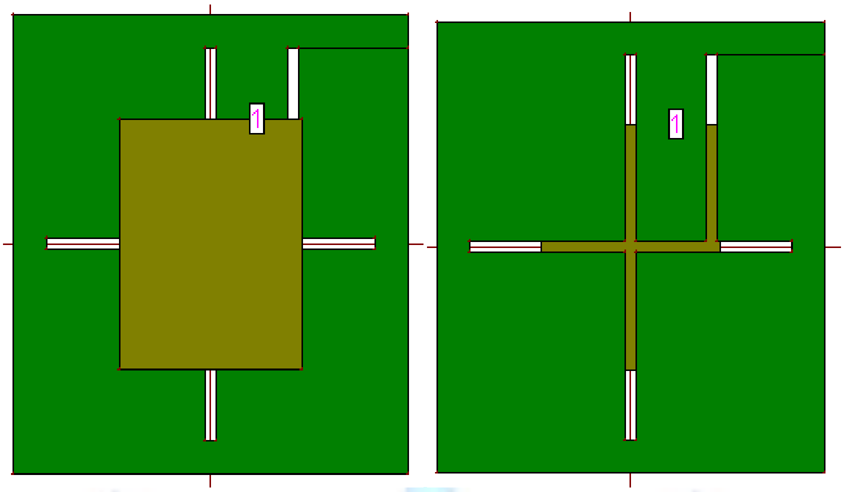

Figure 7. Upper Layer and Ground Layer Antenna 2

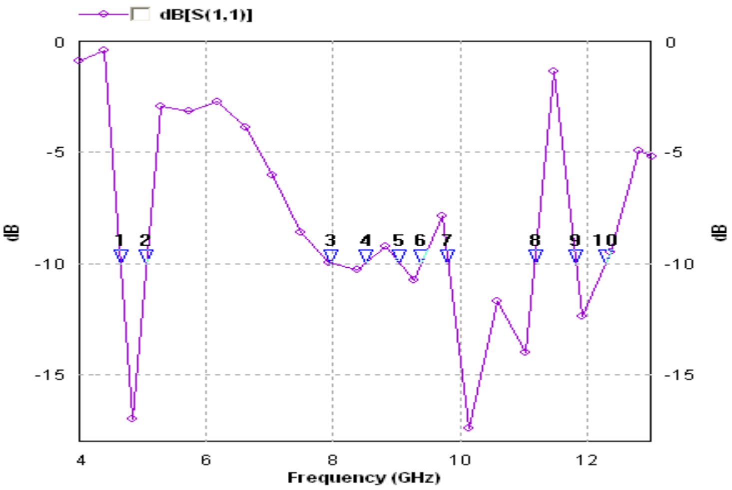

Figure 8. Return Loss of Multiband Antenna

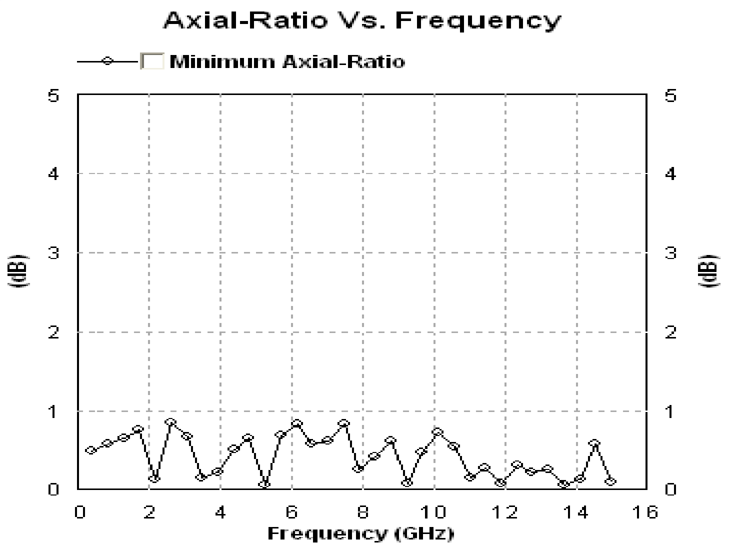

Figure 9.Graph of Axial Ratio Vs. Frequency of Multiband Antenna

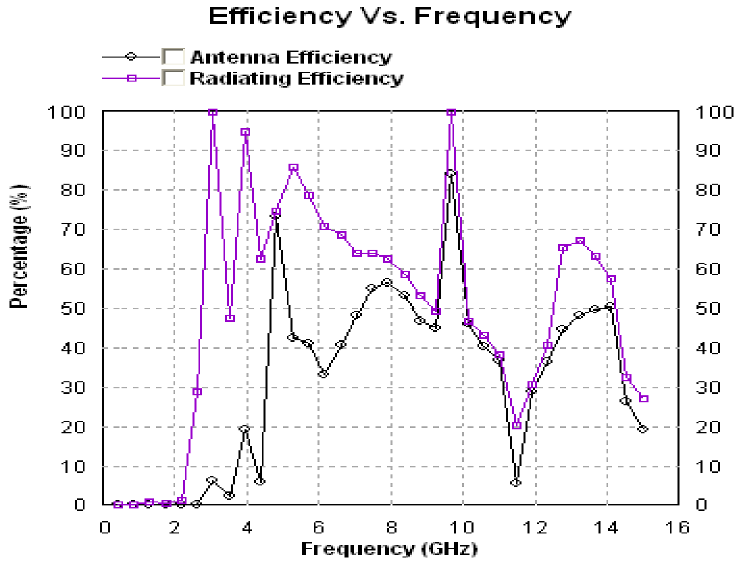

Figure 10.Graph of Efficiency Vs. Frequency of Multiband Antenna

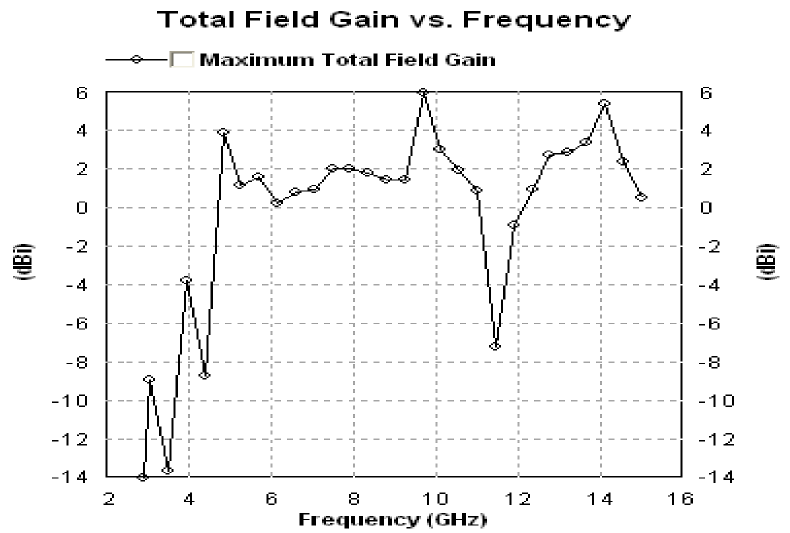

Figure 11.Graph of Total Field Gain Vs. Frequency of Multiband Antenna

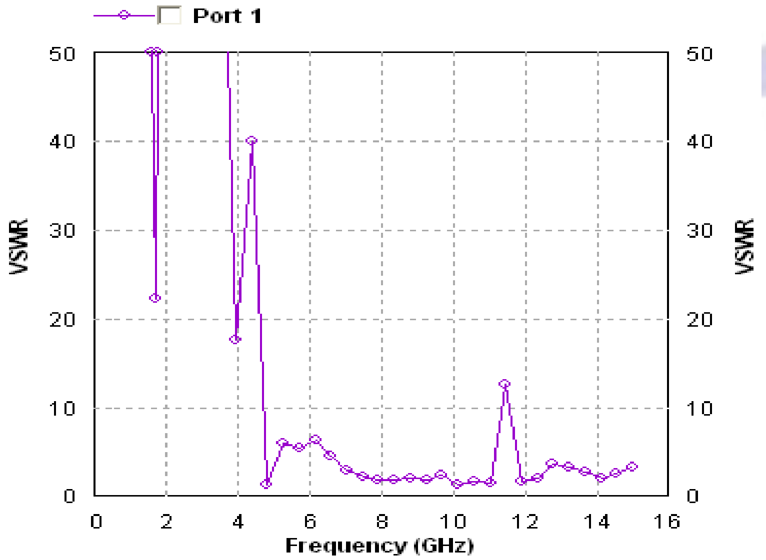

Figure 12.Graph of VSWR of Multiband Antenna

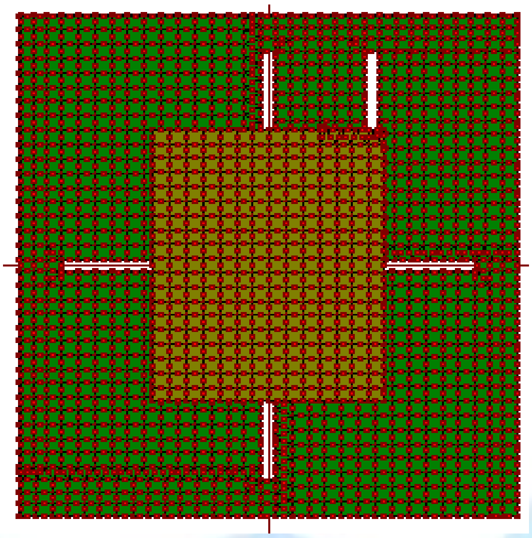

Figure 13.Graph of Meshing of Multiband Antenna

4. OUTCOMES AND DISCUSSIONS:

From the Simulation result of Antenna 1 and Antenna 2, it is observed that Antenna 1 is a compact Broadband Microstrip Antenna which bandwidth is 55%. And it works in 6.71445GHz to 11.9362GHz. (Broadband Multiband Antenna) and also useful in C-band and X-band Application. The result shows that the return loss of -20.08 dB is achieved at the resonant frequency of 7.941GHz, From Antenna2-it is observed that, in 4.85 GHz, 8.382GHz ,9.265 GHz, 10.15GHz, and 11.91GHz resonance frequency the impedance bandwidth (VSWR ≤ 2) below -10 dB return loss obtained are 405 MHz, 552 MHz, 331 MHz, 1.3645GHz and 4.57GHz. The proposed multiband antenna consists of a single layer patch antenna with two parallel slots designed in Ground Plane. The result shows that the return loss of -16.97 dB is achieved at the first resonant frequency of 4.853GHz, -10.30dB at the second resonant frequency of 8.382GHz, -10.73 dB at the third resonant frequency of 9.265GHz, -17.38 dB at the fourth resonant frequency of 10.15GHz and -12.37 dB at the fifth resonant frequency of 11.91GHz. From the Simulation result of Compact Multiband Antenna of Axial Ratio, Total Field Gain, Radiation Efficiency and Antenna Efficiency, and VSWR are shown in Figure 3,4,5,6 and Figure 7. IE3D is employed to analyse the proposed antenna and simulated results in return loss, Axial Ratio, Total Field Gain, and VSWR plot is presented.

5. CONCLUSION:

A compact broadband microstrip patch antenna-1 has been designed for X-band applications communication systems. The reflection coefficient is below −10 dB from 6.71445GHz to 11.9362GHz. The performance is more than meeting the demanding bandwidth specification to cover the 6.71445-11.9362GHz frequency band.from the simulation results we achieve 55% impedance bandwidth (6.71445-11.9362GHz) from antenna 1, obtained impedance bandwidth notch and achieve multiband 8%(4.66724-5.07243GHz), 6.7% (7.95-8.50),3.5%(9.04591-9.37731GHz), 13% (9.8049-11.1694GHz), 3.7% (11.817-12.2742GHz) from antenna-2. At the same time, the antenna is thin and compact with the use of low dielectric constant 4.4 substrate material. And A compact Multiband microstrip patch antenna-2 has been designed for C-band Application and X-band applications. It provides guidance on the design and optimization of double cross slotted in finite ground plane with simple microstrip patch antenna. Comparing between antenna 1 and antenna 2; antenna 1 design for compact broadband antenna for X-band applications and antenna -2 is design for compact multiband Antenna for C-band application and X-band application. Excellent agreement the simulation results is obtained.

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