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Design & Practical Investigation of a Microstrip Patch Antenna at Frequency 2.45GHz

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Abstract— Microstrip antennas are relatively inexpensive to manufacture and design because of the simple to dimensional physical geometry. They are usually employed at UHF and higher frequencies because the size of the antenna is directly tied to the wavelength at the resonant frequency. This paper describes the formulation of a design procedure of a rectangular microstrip patch antenna. The Proposed antenna is simulated using Neutral Electromagnetic Code (NEC) software & evaluated the parameter like radiation pattern, standing wave ratio, reflection coefficient, gain, input impedance etc & compares those with the expected value. All the procedure is done at frequency 2.45 GHz.

Index Terms— Microstrip antenna, physical geometry, radiation pattern, gain & input impedance.

1 Introduction

Microstrip patch antennas have several well-known characteristics, such as low profile, low cost, lightweight, ease of fabrication and conformity (He *et al*., 2008, Zhang and Wang, 2006)[1]-[2]. However, the microstrip antenna inherently has a low gain and a narrow bandwidth [3]. To overcome its inherent limitation of narrow impedance bandwidth and low gain, many techniques have been suggested e.g., for probe fed stacked antenna, microstrip patch antennas on electrically thick substrate, slotted patch antenna and stacked shorted patches have been proposed and investigated (Pozar and Schaubert, 1995,Sanchez-Herndez and Robertson, 1996, Chang, 2000)[4]-[5]. In general, the impedance bandwidth of a patch antenna is proportional to the antenna volume, measured in wavelengths [6]. However, by using two stacked patches with the walls at the edges between the two patches, one can obtain enhanced impedance band width [7]. There has recently been considerable interest in the two layer probe fed patch antenna consisting of a driven patch in the bottom and a parasitic patch (Pozar, 1992, Chair *et al*., 2000, Size and Wong, 2000, Kuo and Wong, 2001, Wong and Hsu, 2001)[9]-[10].

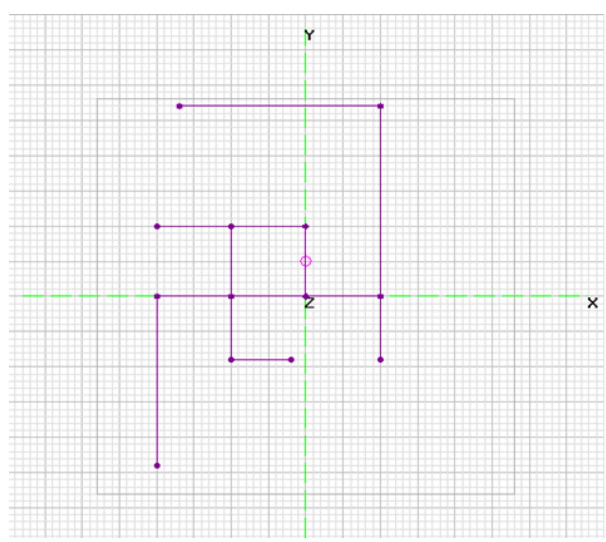
The dielectric loading of a microstrip antenna affects both its radiation pattern and impedance bandwidth [11]-[12]. As the dielectric constant of the substrate increases, the antenna bandwidth decreases which increases the Q factor of the antenna and therefore decreases the impedance bandwidth [13]. This relationship did not immediately follow when using the transmission line model of the antenna, but is apparent when using the cavity model which was introduced in the late 1970[14]. The radiation from a rectangular microstrip antenna may be understood as a pair of equivalent slots. These slots act as an array and have the highest directivity when the antenna has an air dielectric and decreases as the antenna is loaded by material with increasing relative dielectric constant.

The most commonly employed microstrip antenna is a rectangular patch. The rectangular patch antenna is approximately a one-half wavelength long section of rectangular microstrip transmission line. When air is the antenna substrate, the length of the rectangular microstrip antenna is approximately one-half of a free-space wavelength.The antenna is loaded with a dielectric as its substrate, the length of the antenna decreases as the relative dielectric constant of the substrate increases. The resonant length of the antenna is slightly shorter because of the extended electric "fringing fields" which increase the electrical length of the antenna slightly. An early model of the microstrip antenna is a section of microstrip transmission line with equivalent loads on either end to represent the radiation loss.

In high performance aircraft, spacecraft, satellite & missile application where size, weight, cost, performance, ease of installation & aerodynamic profile are constrains, low profile antenna may require, in such case proposed antenna may be used. This model also is used in government & commercial application, such as mobile, radio & wireless communication.

2 Design

The design of the proposed antenna is shown in figure (1).



Here in the proposed antenna rectangular patch model is used. Perfect ground is also given. The radius is 1mm & the height of the sub-

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strate is 1.6mm

3. SIMULATED RESULTS

3.1 Reflection Coefficient

The reflection coefficient in semi permeable membranes relates to how such a membrane can reflect solute particles from passing through. A value of zero results in all particles passing through. A value of one is such that no particle can pass. Reflection coefficient or return loss is defined as the ratio of reflected power to the incident power. For practical antenna its value should be less than -10db. . Simulated return loss in case of designed microstrip antenna is – 13.5 db at resonant frequency 2.45 GHz as shown in figure 2.

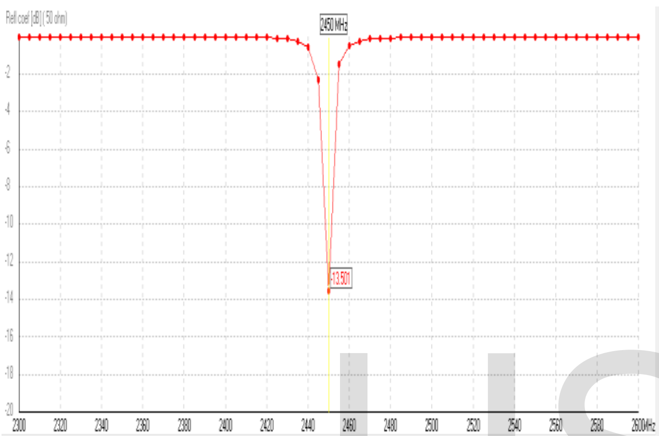

Figure 2: Reflection coefficient versus frequency

3.2 Voltage Standing Wave Ratio (VSWR)

Voltage Standing Wave Ratio is the ratio of output voltage to input voltage. Typical value of VSWR is 1. Here in this proposed model is 1.53.

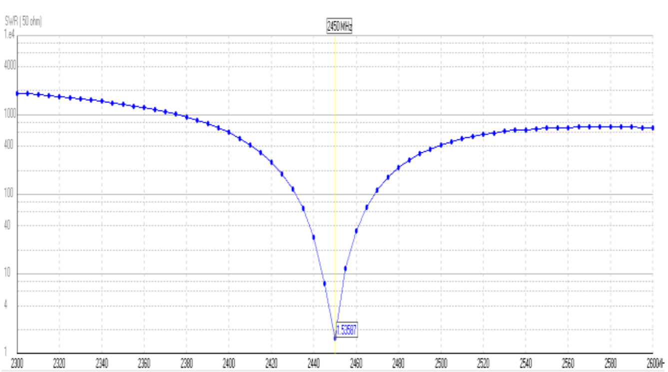

Figure 3: VSWR versus frequency

3.3 Input Impedance

Input impedance of the feeding line is 50 Ω. Here in this proposed model are 51.67 Ω.

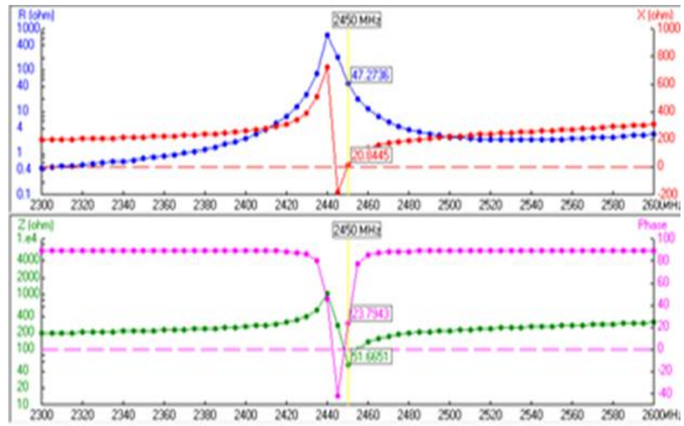

Figure 4: Impedance versus frequency

3.4 Gain

Typical gain of a patch antenna will be greater than 1. Gain of the proposed antenna is 9.67.So which is relatively good for the patch antenna.

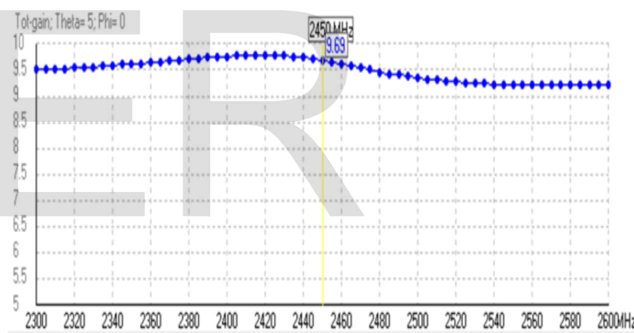

Figure 5: Total gain versus frequency

3.5 Radiation Pattern

In the field of antenna design the term radiation pattern (or antenna pattern or far-field pattern) refers to the *directional* (angular) dependence of the strength of the radio waves from the antenna or other source. It is also the graphical representation of the radiation properties of the antenna as a function of space co-ordinate.

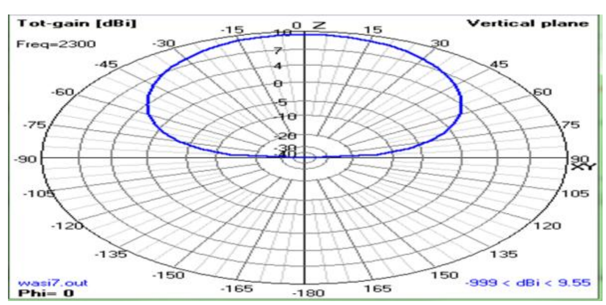

Figure 6(a): Gain

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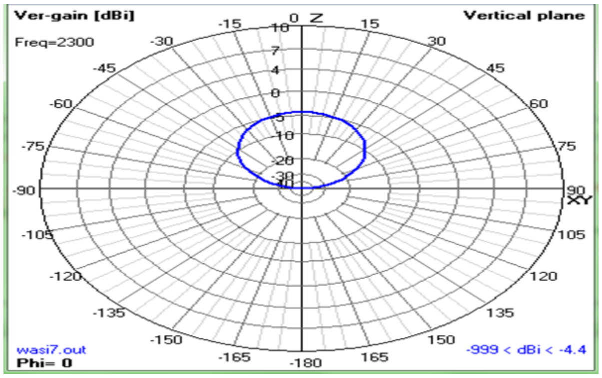

Figure 6(b): Vertical gain

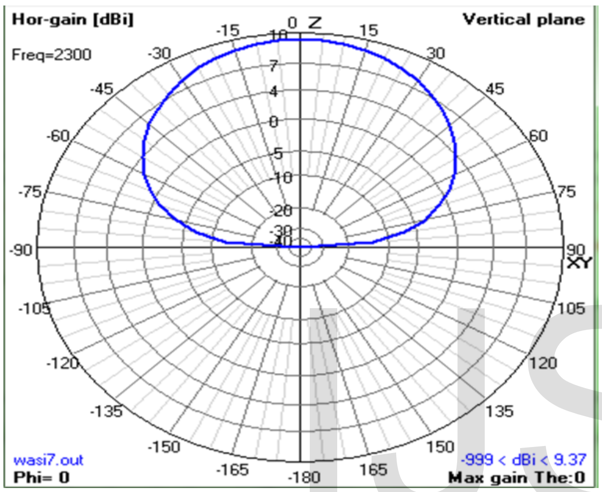

Figure 6(c): Horizontal gain

4 PRACTICAL IMPLEMENTATION

Figure 7: Practical view of the designed antenna

5 CONCLUSION

A wide-band multiple slotted stacked patch antenna has been designed for high gain. A novel technique for enhancing bandwidth and gain of microstrip patch antenna is successfully designed in this paper. The proposed microstrip patch antenna achieves a fractional bandwidth of 21.48% (1.87 to2.32 GHz) at 10 dB return loss. The maximum achievable gain of the antenna is 12.35 dBi. The proposed antenna satisfied almost all the conditions. Due to its high gain and broad bandwidth more applications can be anticipated such as wireless communication, Wimax and Bluetooth etc.

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