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Rectangular Microstrip Patch Antenna With FSS And Slotted Patch To Enhance Bandwidth At 2.4 Ghz For WLAN Applications

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Abstract: Microstrip patch antennas are mostly known for their versatility in terms of possible geometries that makes them applicable for many different situations. The lightweight construction and the suitability for integration with microwave integrated circuits are two more of their numerous advantages. Patch antenna has a narrow bandwidth so it has a complexity in tunings, so there is a requirement to increase the bandwidth of patch antenna. This paper presents a rectangular microstrip patch antenna with FSS and Slotted patch to enhance bandwidth of 2.4 GHz simple rectangular microstrip patch antenna which work on IEEE 802.11b and IEEE 802.11g standard applications. This antenna is mounted on rectangular patch with air gap to enhance bandwidth for WLAN applications.

Keyword: bandwidth, microstrip patch antenna, resonance frequency, VSWR, microstrip feed.

I. INTRODUCTION

The development of wireless applications increase in recent years one particular application that has experienced this trend is wireless local area network (WLAN). The wireless applications that have selected to be studied is 2.4GHz frequency which is based on IEEE 802.11b and IEEE 802.11g for WLAN and WIMAX applications. The microstrip patch antenna has inherent advantage of small size, low profile, light weight and ease of integration with other circuits. It is very suitable for wireless communication system[1-4]. The most serious problem of patch antenna is its narrow bandwidth, cause of narrow bandwidth simple microstrip antenna could not full fill the requirement of bandwidth at 802.11g standard. Therefore there is a need to enhance the bandwidth of microstrip antenna for WLAN application. This paper investigates a technique which can enhance the bandwidth of microstrip antenna without increasing the lateral size and the complexity of microstrip patch antenna. The frequency selective surface (FSS) structure has a phenomenon with high impedance surface that reflects the plane wave in-phase and suppresses surface wave [5-7]. A patch antenna with FSS slotted patch structure can improve its radiation efficiency, bandwidth, and gain, moreover. In this microstrip antenna take the advantage of air gap to lower the effective permittivity and increase the total thickness of microstrip antenna which is essential. This bandwidth enhancemented microstrip antenna operating at 2.4 GHz frequency.

II. MICROSTRIP PATCH ANTENNA DESIGN

Microstrip patch antenna consists of very thin metallic strip placed on ground plane where the thickness of metallic strip is restricted by t<< λ_0 and the height is restricted by$0.0003\lambda_0 \leq .05\lambda_0$ [8-10] microstrip patch is designed so that its radiation pattern maximum is normal to the patch. For a rectangular patch, the length l of the element is usually $\lambda_0/3 < L < \lambda_0/2$. There numerous substrates that can be used for the design of microstrip antennas and their dielectric constants are usually in the range of $2.2 \leq \varepsilon_r \leq 12$. In this paper Fr-4 lossy (ε_r = 4.33) is use to implement the rectangular microstrip patch antenna. The performance of microstrip antenna depends on its dimension, operating frequency, radiation efficiency, directivity, return loss and other parameters are also influenced. For an efficient radiation, the practical width of the patch can be written as [8, 9, 11]

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

and the length of antenna becomes

$$L = \frac{1}{2 f_r \sqrt{\varepsilon_{eff}}\sqrt{\mu_0\, \varepsilon_0}} - 2\,\Delta L$$

Where

$$\Delta L = 0.41h \frac{\varepsilon_{eff} + 0.3}{\varepsilon_{eff} - 0.258} \times \frac{\left(\frac{w}{h} + 0.264\right)}{\left(\frac{w}{h} + 0.8\right)}$$

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2\sqrt{1 + \frac{h}{w}}}$$

Where λ is the wavelength, f_r is the resonant frequency, L and W are the length and width respectively and ε_r is the dielectric constant in the following figure 1 shows an antenna that has been designed at 2.4 GHz frequency. Microstrip patch antenna has length (L) = 14.889mm, width(W) 12.196mm, patch thickness (t) is 0.038 mm and substrate height(h) is 1.6mm. Microstrip feed is used to feed patch which has 3mm width and feeding point is 3mm from centre along with length.

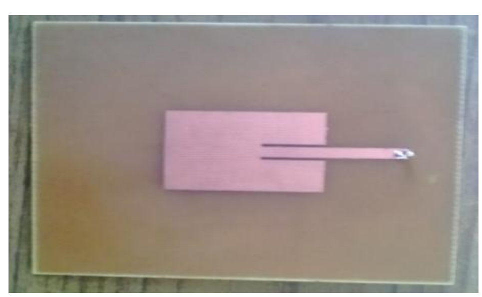

Fig.1 Fabricated Microstrip patch antenna

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Table 1 Design parameters of microstrip patch antenna.

Simulation Parameters	value
Width	24.392 mm
Length	29.778 mm
Location of the probe	3 mm

III. SIMULATED AND MEASURED RESULTES OF PATCH ANTENNA

Proposed antenna has been simulated by electromagnetic simulator, CST software. Fig.2 show return loss (S_{11})= -15dB and 41MHz bandwidth at 2.4 GHz frequency and Gain, VSWR, Directivity characteristics are shown in Fig. 4, 5 respectively.

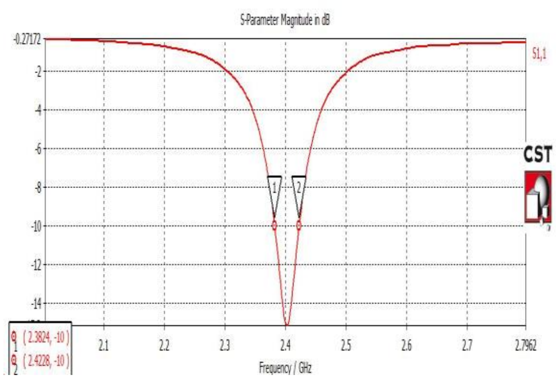

Fig.2 Simulated graph of return loss

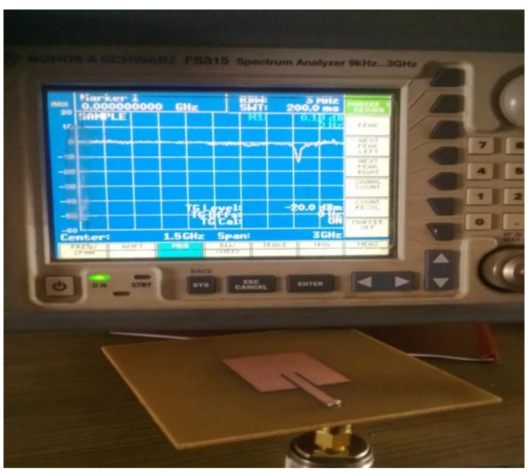

Fig.3 Measured graph of return loss

Table 3 Simulated and measured result comparison

Parameters	Simulated (2.4 GHz)	Measured (2.4 GHz)
Return Loss (S_{11})	-15 dB	-13 dB
Bandwidth	41 MHz	38 MHz

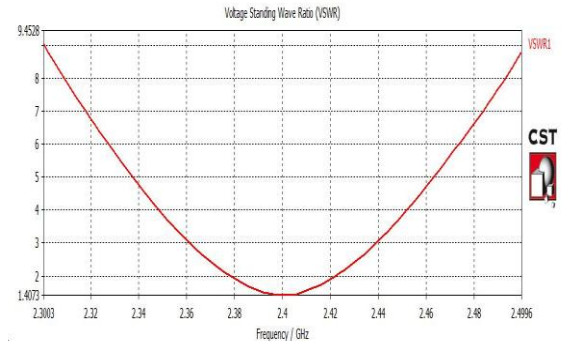

Fig.4 Simulated VSWR pattern

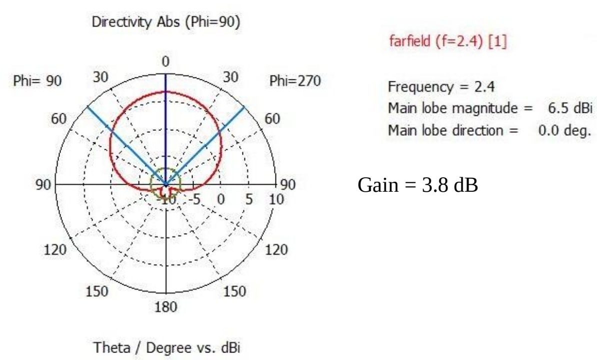

Fig.5 Simulated rdiation pattern

IV. RECTANGULAR MICROSTRIP ANTENNA WITH FSS AND SLOTTED PATCH

The proposed antenna is composed of rectangular patch antenna and FSS with slotted patch, which is shown below. A rectangular ground plane and substrate, and a feed probe connected to the patch. The thickness of the substrate with dielectric permittivity of 4.33 is 1.6mm. A copper plate with dimensions of 80mm*80mm and thickness of 0.038 mm is used as the ground plane. Length of patch is 24.39 mm and width is 29.77 mm. FSS placed above the patch with 9 mm air gap and slotted patch placed on 1.6 mm height substrate. This antenna has been designed to work at 2.4 GHz frequency. The complete structure of antenna has shown in Figure 7.

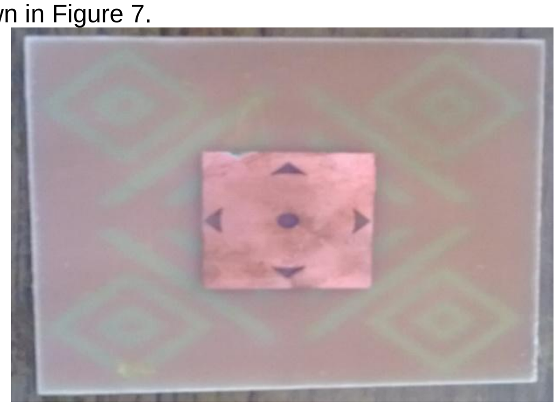

Fig.6 Fabricated FSS

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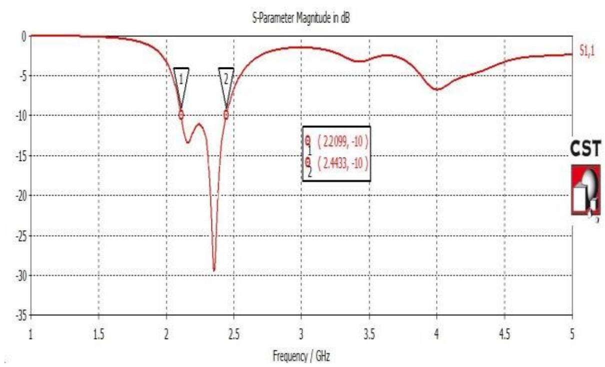
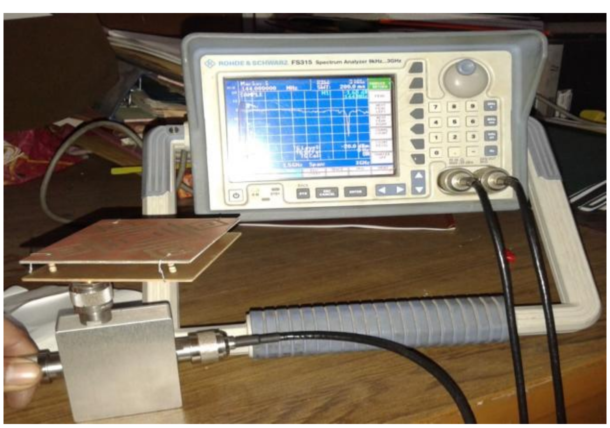
Fig. 7 Fabricated microstrip antenna with FSS and slotted patch

V. SIMULATED AND MEASURED RESULTS OF PRAPOSED ANTENNA

Slotted patch is used to study its impact on the bandwidths and resonant frequencies of FSS patch antenna operating at 2.4 GHz. In simulations, the characteristics of FSS patch antenna have been obtained by using the Computer simulator Technology (CST). Simulation results of the return loss, VSWR, radiation pattern, directivity of proposed patch antenna have been presented and compared.



(a) Simulated Return loss of dual patch antenna



(b) Measured Return loss of fabricated dual patch antenna

Fig.8 Graph of return loss

Fig.8 Gain of microstrip dual patch antenna

Table 4 Comparison of Simulated and measured result.

Parameters	Simulated (2.4 GHz)	Measured (2.4 GHz)
Return Loss (S_{11})	-30 dB	-32 dB
Bandwidth	234 MHz	226 MHz

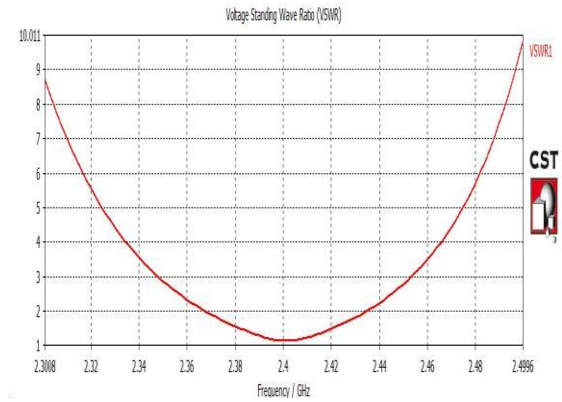


Fig.9 VSWR pattern of dual patch antenna

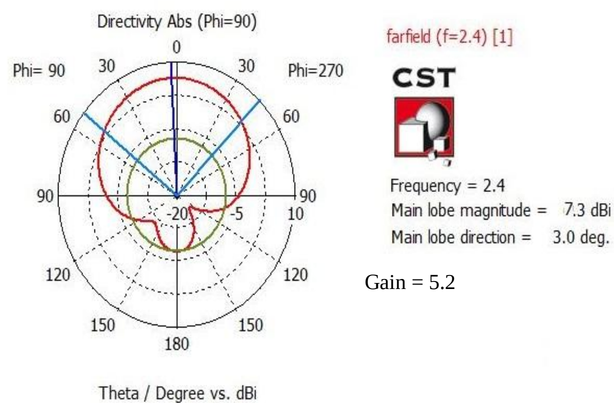


Fig.10 Simulated radiation pattern

Table 5 Comparison between simulated results microstrip patch and FSS with slotted patch

Parameters	Single patch	With FSS and slotted patch
Bandwidth	41 MHz	234 MHz
Gain	3.8 dB	5.2 dB
VSWR	1.4	1.2
Return loss	-15 dB	-30 dB
Directivity	6.5 dB	7.3 dB

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VI. CONCLUSION

The technique for enhancing bandwidth of the microstrip antenna has been proposed and it can be used for WLAN applications as it fully utilizes the entire 2.4 GHz band. Performance has been increased in term of Bandwidth, Gain, Return loss, VSWR, and Directivity as mentioned. Disadvantages such as it increases the height of the microstrip antenna. Therefore, trade-of issues need to be considered in this design.

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