Rectangular Microstrip Dual Patch Antenna to Enhance Bandwidth at 2.4 GHz for WLAN Applications

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Abstract

Micro strip 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 compact size rectangular microstrip dual patch antenna 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 up to 60 percent 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 IEEE802.11g 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. In dual patch microstrip antenna to enhance the bandwidth, take the advantage of air gap to lower the effective permittivity and increase the total thickness of microstrip antenna which is essential. This bandwidth enhancement microstrip antenna can be deployed for the WLAN application 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 $t << \lambda_0$ and the height is restricted by$0.0003\lambda_0 \le .05\lambda_0$ [5-7] 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 $\lambda_0/3 < L < \lambda_0/2$. Therenumerous substrates that can be used for the design of microstrip antennas and their dielectric constants are usually in the range of $2.2 \le \varepsilon_r \le 12$. 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 [5, 6, 8]

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

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 0.038mm 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.

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

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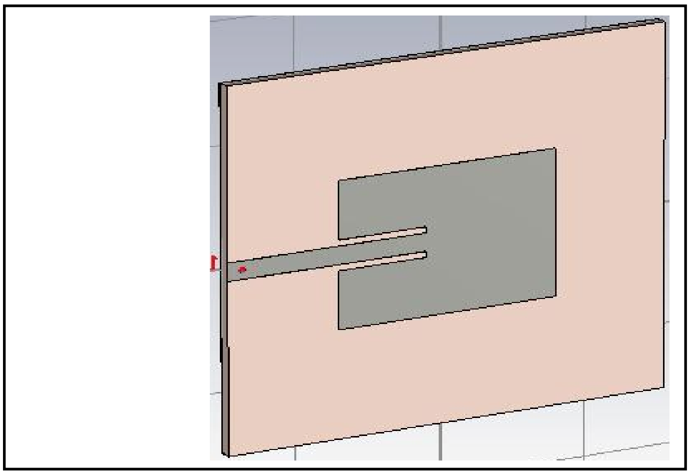

Fig. 1: Microstrip Patch Antenna

III. Simulated Resultes of Patch Antenna

Proposed antenna has been simulated by electromagnetic simulator, CST software. Fig.2 show return loss (S_{11})= -30dB and 41MHz bandwidth at 2.4 GHz frequency and Gain, VSWR, Directivity characteristics are shown in Fig. 3, 4, 5 respectively.

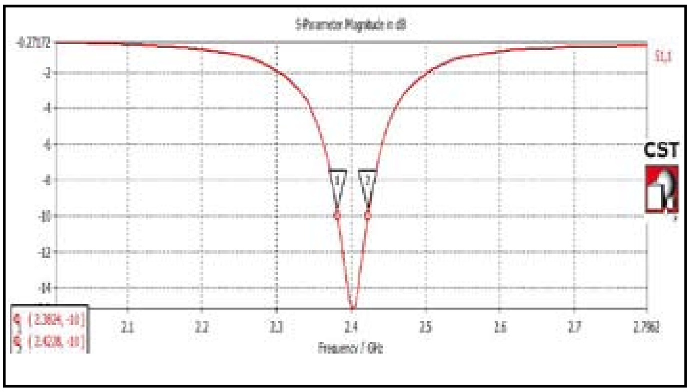

Fig. 2: Simulated Graph of Return Loss

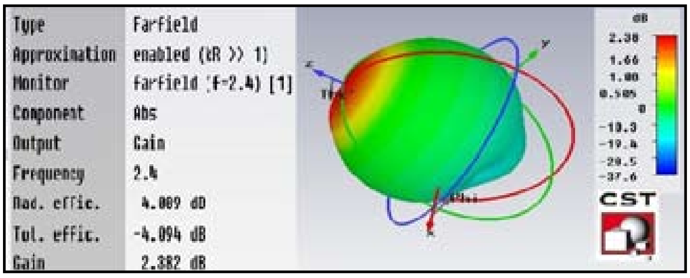

Fig. 3: Simulated Gain Pattern

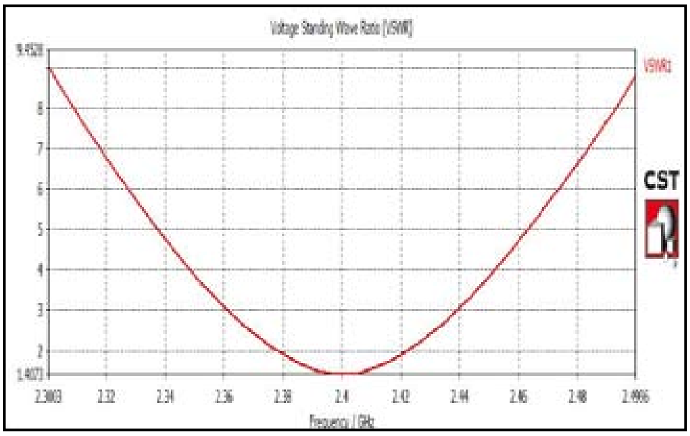

Fig. 4: Simulated VSWR Pattern

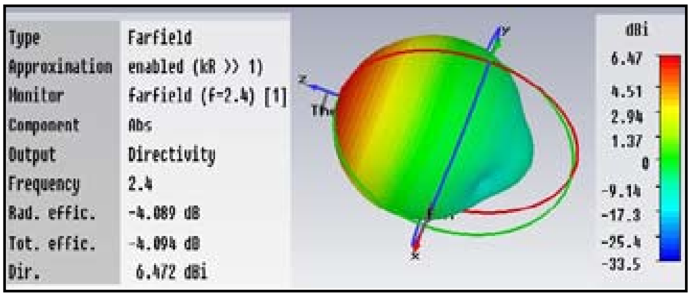

Fig. 5: Simulated Directivity Pattern

IV. Microstrip Dual Patch Antenna

Microstrip dual patch antenna consists of single patch antenna and another compact size patch antenna which is placed on first patch antenna with 10 mm air gap. Dual patch antenna is shown in fig. 6. Compact patch antenna have same substrate FR_4 lossy with 1.6mm height, dimension of compact patch are shown in Table 2.

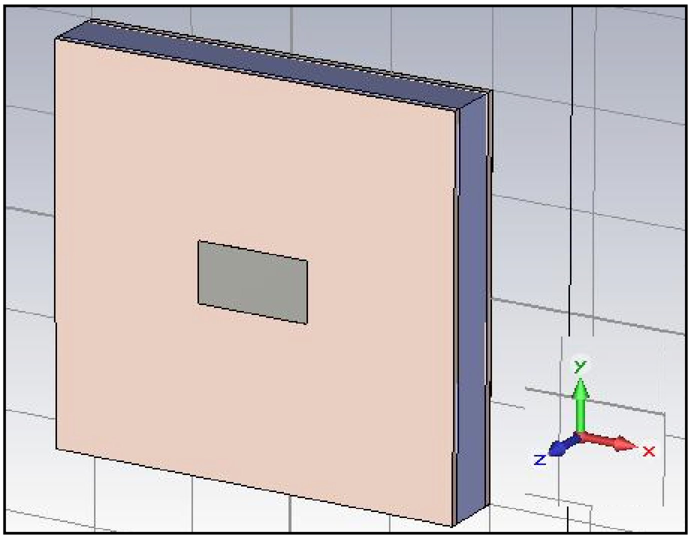

Fig. 6: Microstrip Dual Patch Antenna

Table 2: Parameters of Compact Patch

Simulation parameters	value
Width	12.252 mm
length	23.778 mm
Air gap	10 mm

V. Simulated Results of Microstrip Dual Patch Antenna

Simulated results of microstrip dual patch antenna is shown in fig. 7 which have -40 dB return loss with increased bandwidth up to 64 MHz at 2.4 GHz frequency which is 60 percent more than single patch antenna, gain and directivity are also increased at 2.4 GHz frequency. Gain, VSWR and Directivity are shown in fig. 8, 9, 10 respectively.

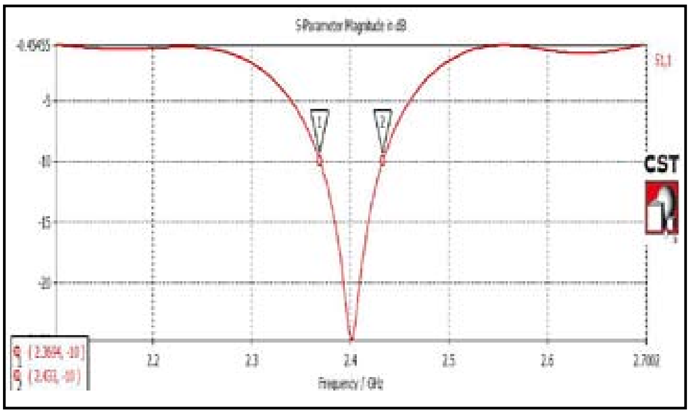

Fig. 7: Return Loss of Microstrip Dual Patch Antenna

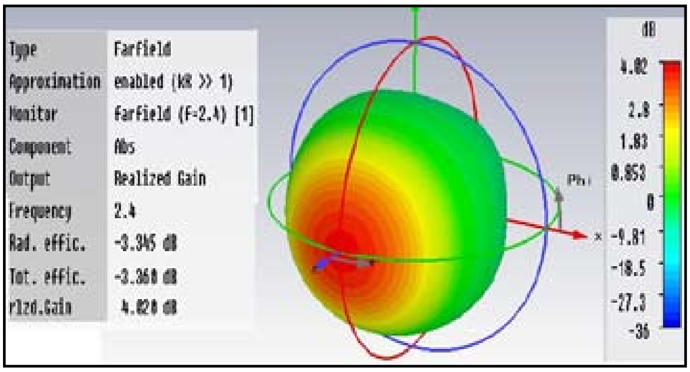

Fig. 8: Gain of Microstrip Dual Patch Antenna

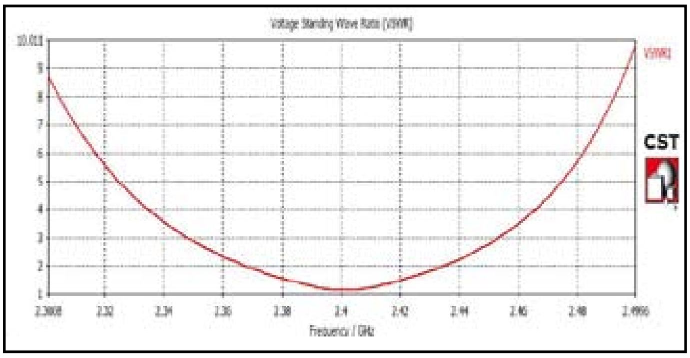

Fig. 9: VSWR Pattern of Dual Patch Antenna

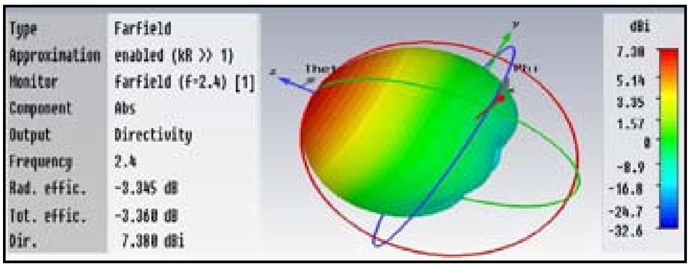

Fig. 10: Directivity Pattern of Dual Patch Antenna

Table 3: Comparison Between Simulated Results of Single and Dual Patch Antenna

Parameters	Single patch	Dual patch
Bandwidth	40 MHz	64 MHz
Gain	2.382 dB	4.020 dB
VSWR	1.40	1.26
Return loss	-30 dB	-40 B
Directivity	6.47 dBi	7.38 dBi

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 of dual patch microstrip antenna has been increased in term of Bandwidth, Gain, Return loss, VSWR, and Directivity As mentioned, this technique has its advantages such as it does not increase the lateral size of the microstrip antenna and 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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