A NOVEL DUAL BAND PATCH ANTENNA FOR WLAN COMMUNICATIONS

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Abstract- ***A dual-band patch antenna for Wi-Fi network and (WLAN) wireless communications, operating at 2.45 and 5 GHz has been designed and simulated results have been presented in this paper. The designed antenna has a rectangular patch of dimension W X L mounted on the top of a dielectric substrate. Multiple T-shaped and rectangular slots embedded on the antenna patch are used to obtain the dual band operation of the antenna. The substrate material used is RT-duriod with dielectric constant 2.2 resulting in better efficiency and low substrate losses. The designed antenna is fed by a coaxial probe which provides low substrate losses and an easy impedance matching of the antenna load. Size reduction in the antenna used for WLAN is important because a compact size of the antenna can be easily embedded within the other WLAN circuitry. A reasonable reduction in the size of the antenna has been observed. The antenna has high gain and low VSWR at the desired frequency bands. The antenna has the gain of above 3.5 dBi and 7 dBi for the lower and higher frequency bands simultaneously and efficiencies over 90% with the antenna VSWR below 1.5 for both the operating frequencies. The simulated results along with the radiation patterns have been presented in this paper. Details of the proposed antenna design are presented and discussed, which can be a candidate for the requirement of WLAN, operating at 2.4 and 5 GHz range. The antenna is simulated using a 3D modeling software Ansoft HFSS.***

1. INTRODUCTION

In recently used wireless communication systems, such as WLANS, research and development efforts are being made to reduce the size and enhance the performance. WLAN has shown a rapid growth and there are several IEEE standards already in existence, namely 802.11a, b, g and j. From the frequency spectrum, it has been observed that we have a limited band at 2.4 GHz band, and WLAN must be shifted to the higher and more abundant band 4.9 GHz and 5 GHz. So a necessity of dual band antenna operating at these frequency bands arises. Many dual band antennas has been proposed and designed in the recent years. This paper describes a novel patch antenna for WLAN with the following design specifications and results. Patch antennas are much attractive and popular due to their natural advantages such as small size light weight, conformability and low costs. Dual-band operation is an important subject in patch antenna designs. Recently, several designs of the dual-band slot-loaded micro-strip patch antennas have been reported. The designed presented in various papers describes different shapes of slots to obtain the dual band operation. The dual-band operation in this antenna design is achieved by embedding three T-shaped open slots and two rectangular slots in the antenna patch the lengths of the T-shaped slots has been adjusted in order to obtain the desired frequency band operations of the antenna. The Rogers RT/duriod 5880 material with dielectric constant 2.2 is used for substrate have stable magnetic performance, so that the proposed design of patch antenna has, better performance, reasonable size reduction and simple structure and is easy to be fabricated. This dual band antenna has been fed by a pec probe using a coaxial feed mechanism which provides easy fabrication and impedance matching to the designed antenna. However, the designed antenna adopted has narrow impedance bandwidths of the two operating frequencies, usually on the order of 2% or less. In this paper, a dual-band WLAN antenna, and the simulated results of the proposed antenna and its S_{11} characteristic along with the radiation patterns has been presented and discussed.

2. DESIGN AND SIMULATION

In this paper, a dual-band WLAN antenna printed on rogers RT/duriod 5880, is presented and report the simulated results of the proposed antenna on its S_{11} prototypes of the proposed design were constructed and studied. Figure 1 shows the physical configuration of the proposed micro-strip patch antenna. The parameters of the material adopted are dielectric constant= 2.2, h = 1.6 mm, tan δ = 0.009, relative permeability = 1. The patch is fed by a coaxial probe placed along the central line with a distance H to the bottom side. The dimensions of the rectangular patch are W X L. The dual T-slots and dual rectangular slots are located symmetrically along the center line of the patch; one inverted T-slot in the middle of the top of the patch and has a narrow width of *S*. The lengths of vertical and horizontal arms are denoted as *h* and L'. The symbol *D* represents the length between the horizontal arms.

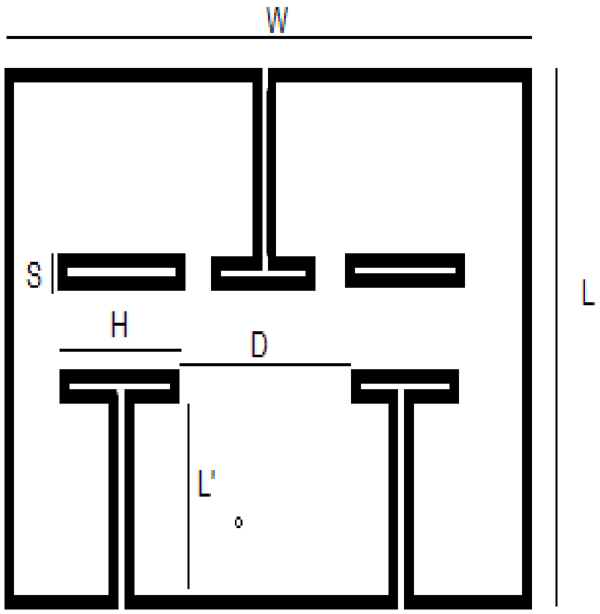

Fig-1 Configuration of Antenna

For a regular rectangular patch without slot, its resonant frequency in terms of patch length is given by expression

$$f_c = \frac{C}{2L\sqrt{\varepsilon_r}}$$

Where *C* is the velocity of light in free space, ϵ_r is the equivalent permittivity. By choosing the feed location, the first two modes TM_{10} and TM_{11} can be excited. In the study, we found that with an increase of H, the resonant frequency shifted to low frequency and the bandwidth of the lower frequency band becomes a bit narrower while the bandwidth of higher frequency band becomes broader.

In the proposed design, the resonant frequency is slightly affected by the narrow slots and by increasing the length of the inverted T-slot a decrease in the return loss has been observed. The height of substrate and the width of slots are much smaller comparing with the central frequencies wavelength; therefore, the frequency is decided by the geometry of the rectangular patch, the dimensions of which can be estimated.

The simulated rectangular patch antenna usin g ansoft hfss has been shown below.

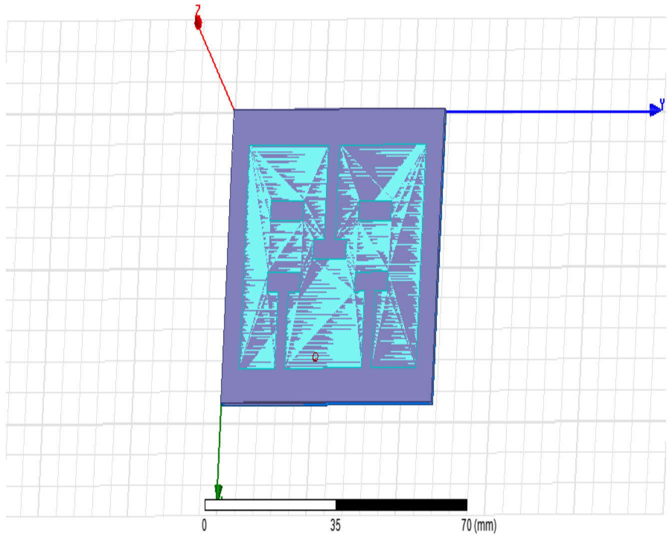

Fig-2 Simulated antenna using HFSS

1. RESULT AND ANALYSIS

The characteristics of the slotted patch antenna have been simulated by HFSS software. Fig.3. shows the simulated and measured S_{11} versus frequency graph, from which, we can see that the S_{11} characteristics of the antenna in the bandwidths of 2.4(2.4070-2.7337 GHz) and 5. GHz is below -11 dB i.e. -16.12dB at 2.4 GHz and -21.60 dB at 5 GHz.

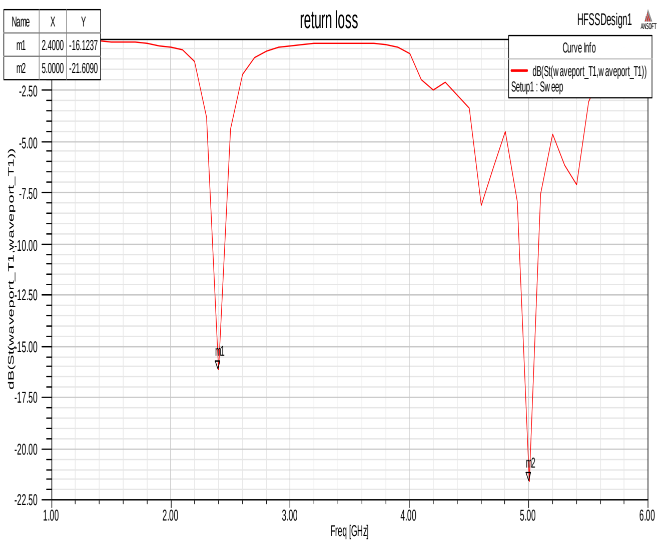

Fig-3 Measured S Parameter

The simulated radiation patterns of the antenna at 2.4 GHz are shown in Fig. 4. and Fig 5.The peak gain of the designed antenna is 3.52 dB at 2.4 GHz

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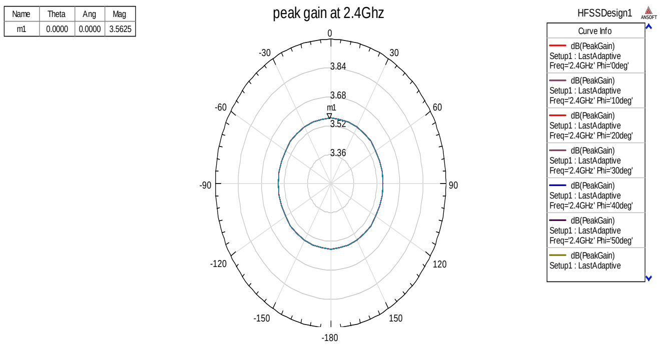

Fig-4 Radiation pattern (dB [peak gain]) at 2.45 GHz

The peak antenna gain of 7.13 dB has been observed at 5 GHz.

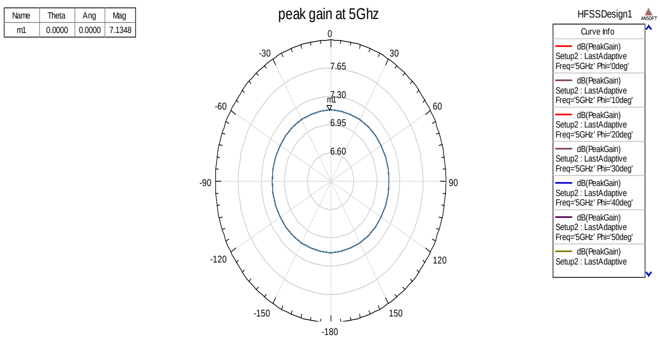

Fig-5 Radiation pattern peak gain of the antenna at 5 GHZ.

For the antenna, the lower operating band has a peak gain of 3.52 dBi, and that of the higher band is 7.13 dBi. The VSWR at the two operating bands of the proposed antenna is as shown in Fig.6.

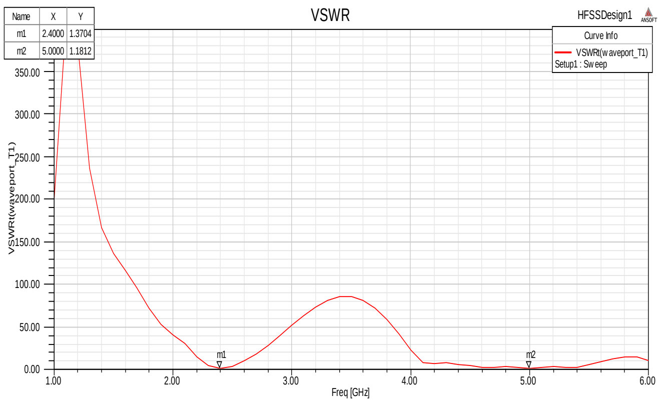

Fig.-6 VSWR graph of the designed antenna

The voltage standing wave ratio of thee designed antenna over the dual operating bands is 1.37 at 2.4 GHz and 1.18 at 5 GHz. The antenna efficiency over the operating band 2.4 GHz is as shown in radiation pattern below in Fig. 7.

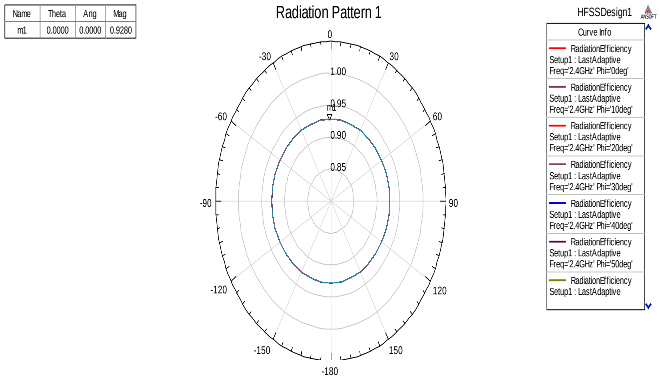

Fig-7 Antenna efficiency at 2.4 GHz

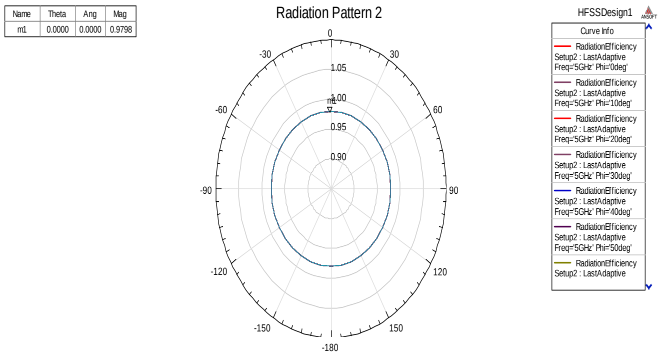

Fig-8 Antenna efficiency at 5 GHz

The antenna efficiency of the proposed antenna at 2.4 GHz is 92.80 % and at 5GHz is 97.98%. The only parameter of main concern is bandwidth of the simulated antenna. It resonates in a very narrow bandwidth.

CONCLUSION

The designed antenna gain i.e. 3.52 dB and 7.13 dB on the operating frequencies 2.4 and 5 GHz respectively are acceptable over the desired frequency band, with as low VSWR as 1.37 and 1.18 at 2.4 GHz and 5 GHz respectively. The results of the antenna are acceptable for the WLAN applications. The bandwidth of the simulated antenna is very narrow. It can be acceptable for Wi-Fi networks. Moreover, it is can be improved in future. There are many methods including truncation, increasing substrate thickness, decreasing dielectric constant of the material used to improve the bandwidth of the antenna. However, the wider bandwidth may be come from the larger magnetic loss. Thus, its gain will be decreased as the payment for the bandwidth broadening. The application prospect of the antenna can be attractive if we pay more efforts to improve the antenna gain. Comparing with rectangular micro-strip antennas on normal dielectric substrate, the overall size of this antenna is reduced to great extent.

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