Dual Band Compact Size Microstrip Antenna Operating at 2.45 GHz and 5.8 GHz for WLAN Applications

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Abstract: WLAN (Wireless Local Area Network) is one of the most widely used technologies in today's world. WLAN is a wireless distribution method for two or more devices that use high-frequency radio waves and often include an access point to the internet. WLAN is used in wireless devices such as laptops, PCs with PCI cards, gadgets, mobile phone and others. Recently, there has been a lot of interest on dual-band and multiband antennas for wireless communication, due to the increasing areas of application which require dual-band or multiband frequency. In this paper, dual band microstrip antenna for WLAN applications to operate at 2.45 and 5.8 GHz are presented. The proposed microstrip patch antenna is compact in size and satisfies requirement of WLAN standards by IEEE 802.11a/b, operating at frequencies ranging between 2.4-2.485 GHz and 5.15-5.35 GHz and 5.47-5.825 GHz. The simulation and parametric studies of the proposed dual band antenna were done using the CST Microwave studio 2012. The antenna has been fabricated and finally experimental and numerical results are carried out and discussed, showing good agreement.

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Keywords: Wireless Local Area Network (WLAN), dual band antenna, Microstrip antenna

1. Introduction

The pattern and relationships between species In the early 1990s, WLAN (Wireless Local Area Network) were very expensive and were only used when wired connections were strategically impossible. By the late 1990s, most WLAN solutions and proprietary protocols were replaced by IEEE 802.11 standards [13]. WLAN prices also began to decrease significantly. Now, WLAN is one of the most widely used technologies in today's communication world. From [6] WLAN is described as a communication system that transmits and receives data using modulated electromagnetic waves, implemented as an alternative for WLAN. It is one reliable and cost effective solution for wireless high speed data connectivity and viable solution for high-speed data connectivity [13, 14]. In this paper, a dual band patch antenna for WLAN application is presented. Basically, the bandwidth of microstrip patch antenna depends on the dielectric material, shape, electrical length of antenna and others. Microstrip patch antennas are very popular and suitable for many wireless communication applications because of their low profile, small size, and low production cost. Antenna design and simulated and measured results will be presented in next sections.

2. Design of Antenna

A dual band microstrip patch antenna for solution standard Wireless Local Area Network (WLAN) is designed. The structure of the proposed antenna includes a H-shaped resonator and a rectangular shaped resonator. The proposed antenna is printed on a double sided FR4 substrate (48 mm × 58 mm × 1.6 mm) with a full ground plane. This microstrip patch antenna is designed and simulated in CST Microwave Studio 2012 software. The value of relative permittivity of the substrate ε_r is 4.5 with thickness of h = 1.6mm. The H-shaped radiator element and the rectangular-shaped element operate at 2.45GHz and 5.8GHz respectively. The structure of the proposed dual band antenna is shown in Figure 1, and Figure 2. The optimal dimensions for the designed antenna are presented in Table. 1.

3. Result and Discussion

Table 1. Dimension of each Parameter

Parameter	Size (mm)
lcut	30
lfed	40
lp	2
lp1	1
lp2	15
lp3	4
lsub	13
wcut	12
wfed	8
wp	20
wp1	16
wp2	6
wp3	3
h	1.6

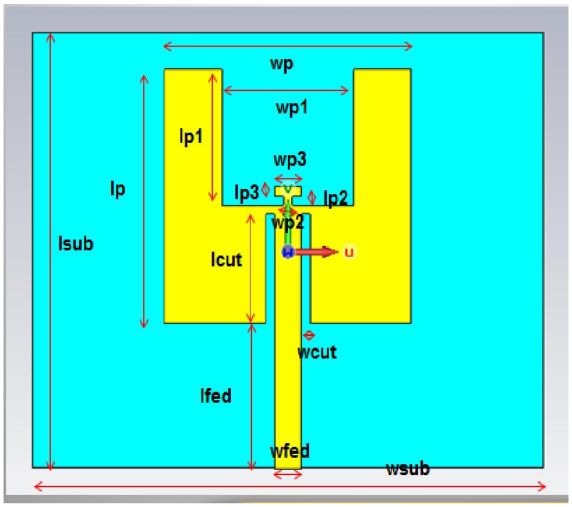

Figure 1. Front view of the proposed antenna structure

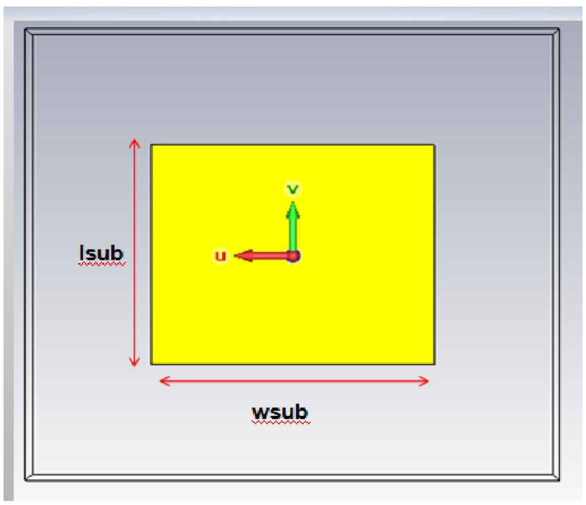

Figure 2. Back view of the proposed antenna structure

The proposed antenna is fabricated and its radiation characteristics are tested using the Network Analyzer and the Anechoic Chamber are presented. Measured results also confirm that the proposed antenna satisfies the requirement of WLAN standards IEEE 802.11a/b, where the operating frequencies between the range of 2.4-2.485 GHz and 5.47-5.825 GHz. It must be noted that the H-shaped is designed to operate at 2.45 GHz, which covers the IEEE 802.11b (2.4-2.485 GHz) and rectangular-shaped operate at 5.8 GHz, covering the IEEE 802.11a (5.15-5.35 GHz and 5.47-5.825 GHz).

The simulated return loss of the proposed antenna is shown in Figure 3. Based on this figure, the return loss shows two resonance at 2.4746 GHz and 5.3255 GHz, hence it fulfilled with the criteria requested. The impedance bandwidth covered frequencies form 2.4316 GHz to 2.5211 GHz, and 5.2564 GHz to 5.3917 GHz for lower and higher frequency band, respectively.

To verify the current distribution effective area, current distribution of the proposed antenna at 2.45 GHz and 5.8 GHz in E-Plane and H-Plane are shown in Figure 4, 5, 6, and 7. Current distribution graphs prove that H-shaped radiation element resonant at 2.45 GHz while the small rectangular-shaped resonant at 5.8GHz.

The comparison of the return loss between simulation and measurement result of the proposed dual band microstrip patch antenna is shown in Figure 8. From the simulation result, frequency drop at 2.4746 GHz and 5.3255 GHz under -10dB and from the measurement result, frequency drop at 2.495 GHz and 5.45 GHz -10dB. This Figure illustrate a very good agreement between simulation and measurement results and show that dual band antenna operates at IEEE 802.11a (5.15-5.35 GHz and 5.47-5.825 GHz) and IEEE 802.11b (2.4-2.485 GHz). Furthermore, the covered frequency for both results is proved that achieved the requirement.

Figure 9, shows the simulated and measured radiation pattern of the proposed antenna at frequency 2.45 GHz for both E-Plane and H-Plane. Also, simulated and measured E-Plane and H-Plane radiation pattern for the designed antenna at 5.8 GHz is shown in Figure 10. From figures 9 and 10, E-Plane radiation pattern of the proposed antenna at the both resonant frequency is in end fire direction against frequencies while H-Plane radiation pattern is nearly Omni-directional.

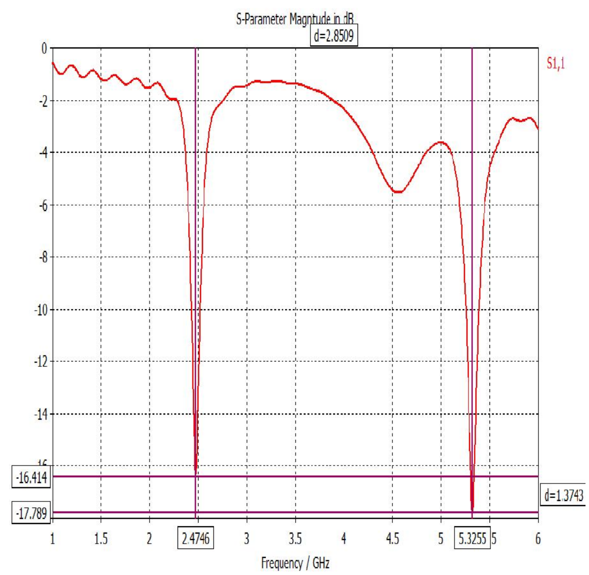

Figure 3. Simulated Return Loss

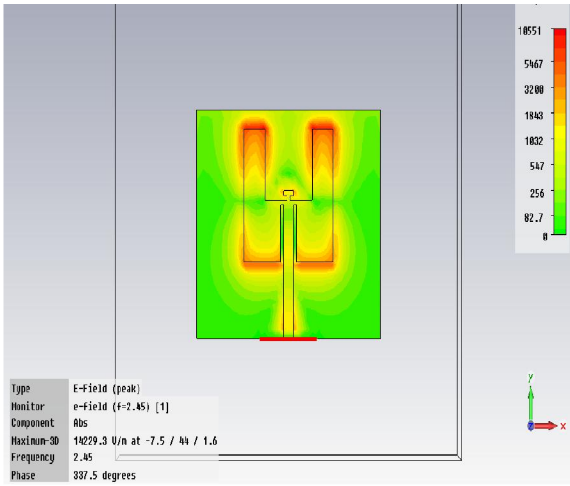
Figure 4. Current distribution at E-Field at 2.45 GHz

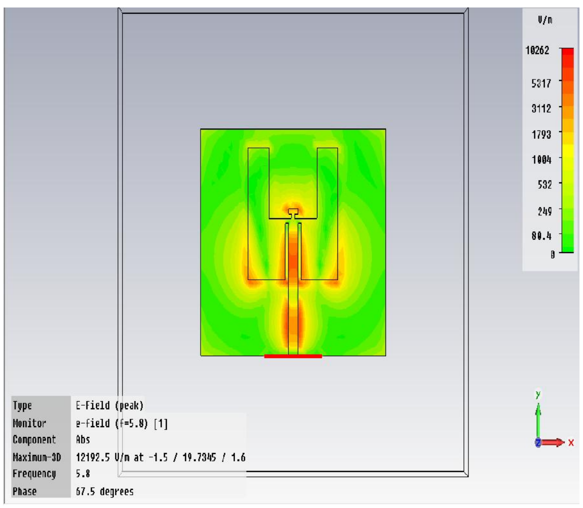
Figure 5. Current distribution at E-Field at 5.8 GHz

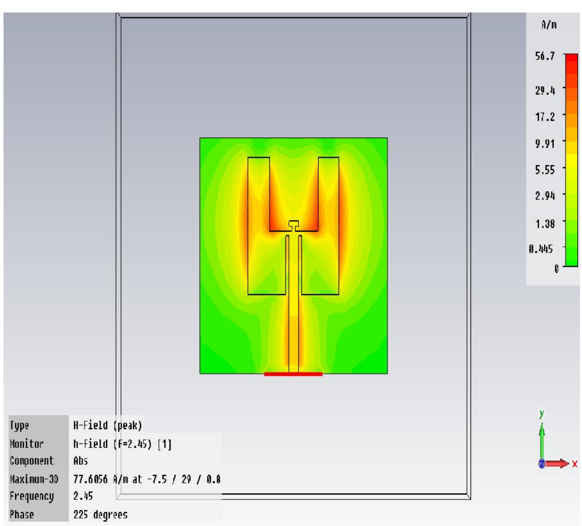
Figure 6. Current distribution at H-Field at 2.45 GHz

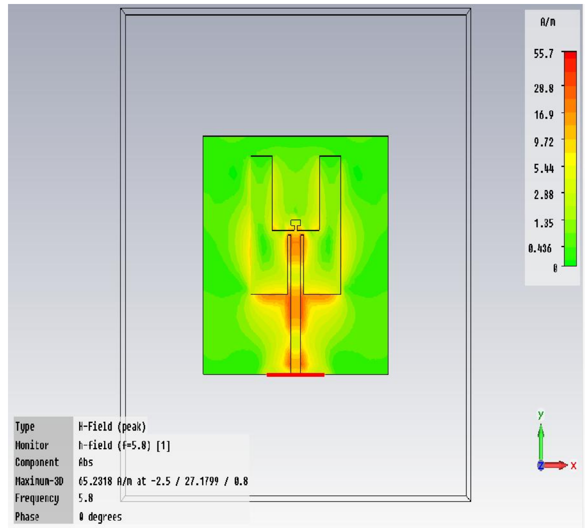
Figure 7. Current distribution at H-Field at 5.8 GHz

4. Conclusion

A compact size dual band microstrip patch antenna operating at 2.45 GHz and 5.8 GHz for WLAN Applications has been designed, simulated, and fabricated. Simulation and measurement results are in a very good agreement. The proposed antenna exhibits two bands, covering 2.45 GHz and 5.8 GHz WLAN with good radiation characteristics in the bands. The dual band antenna achieves the expected outcome and fulfilled the requirement bands frequency and bandwidth specifications of IEEE 802.11a/b. The covered frequency for both results is proved that achieved the requirement. The proposed antenna radiate Omni-directional in H-Plane while E-Plane shows the end fire type of radiation. As a result, the proposed antenna is attractive and can be practical for dual band systems.

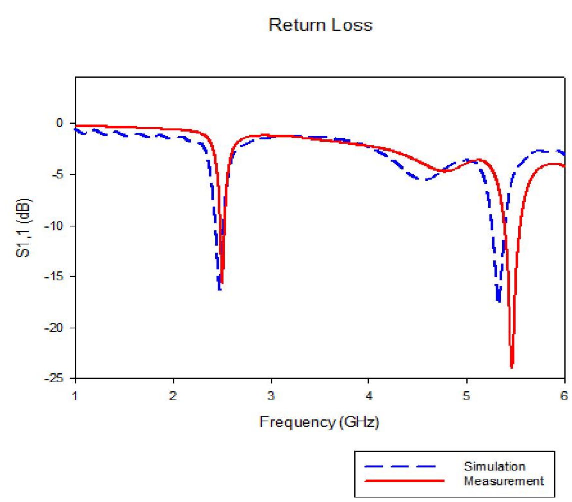

Figure 8. Simulated and Measured Return Loss

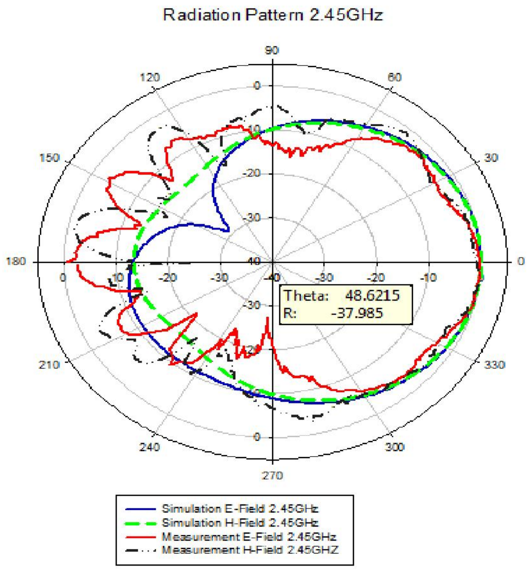

Figure 9. Simulated and Measured Radiation Pattern at 2.45 GHz.

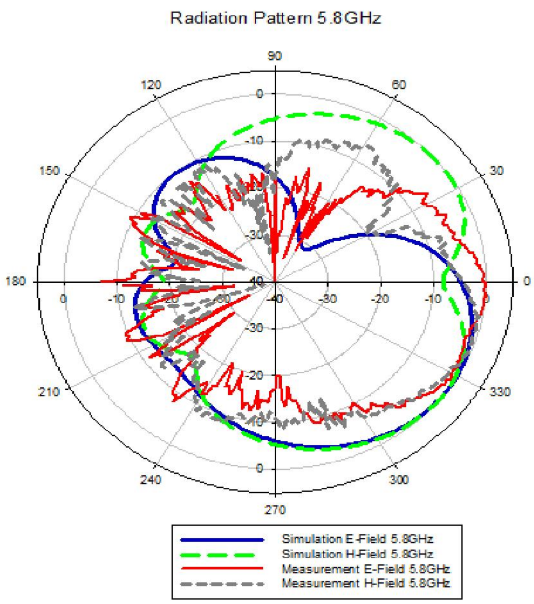

Figure 10. Simulated and Measured Radiation Pattern at 5.8 GHz.

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References

1. Xiao Lei Sun, Li Liu, Cheung SW and Yuk TI. Dual-band antenna with compact radiator for 2.4 GHz, 5.2 GHz and 5.8GHz WLAN applications IEEE Transactions on Antennas and Propagation, Vol. 60, No. 12, 2012.
2. Fitri Yuli Zulkifli, Dian Rodhiah and Eko Tjipto Rahardjo. Dual band microstrip antenna using U and S slots for WLAN application IEEE Transactions on Antennas and Propagation, 2007.
3. Tan YM, Chan YK., Koo VC and Mohammad TI. A novel wideband antenna for dual band WLAN application IEEE Transactions on Antennas and Propagation, 2010.
4. Chien PC, Jwo S S, Chen YD and Guan YC. WLAN antenna design and measurement Progress In Electromagnetics Research, PIER, 2011.
5. Balanis CA. Antenna Theory, Antenna theory analysis and design, 3rd edition, John Wiley and Sons, New York, 2005.
6. Fung C. Basic antenna theory and application BTech thesis, 2011.
7. Barath Kelothu, Subhashini KR and Lalitha Manohar G. A compact high-gain microstrip patch antenna for dual band WLAN applications *IEEE Transactions on Antennas and Propagation*, 2012.
8. Md. Nazmul Hasan, Syed Waqar Shah, Mohammad Inayatullah Babar and Zeeshan Sabir. Design and simulation based studies of a dual band U-slot patch antenna for WLAN application *ICACT*, 2012.
9. Jablun Kerketta and Soubhagya Ranjan Behera. Design of fractal slot antennas for WLAN and WiMAX applications BTech thesis, 2012.
10. Soumya Ranjan Behera and Vishnu V. Dual band and dual polarized microstrip patch antenna BTech thesis, 2010.
11. Nor MZM, S. K. Rahim SK and Sarban MI. Slotted square patch printed monopole antenna with dual band capabilities for WLAN application Proceedings from Asia-Pacific Microwaves Conferences, 2011.
12. Rothith KR, Manoj Joseph CK, Aanandan, Vasudevan K and Mohanan P. A new compact microstrip-fed dual band coplanar antenna for WLAN applications *IEEE Transactions on Antennas and Propagation*, Vol. 54, No. 12, 2006.

13. Crow BP. IEEE 802.11 Wireless Local Area Networks *IEEE Transactions on Antennas and Propagation*, 2012.
14. David VT. Stands on Standards *IEEE Antennas and Propagation Magazine*, Vol. 46, No. 2, 2004.
15. Asrokin A, Rahim MKA and Abd. Aziz MZA Dual band microstrip antenna for Wireless Lan application *Asia-Pacific conferences on applied electromagnetic proceesings*, 2005.
16. Min-Chi Chang and Wei-Chung Weng A Dual-Band Printed Dipole Slot Antenna for 2.4/5.2 GHz WLAN Applications *IEEE Transactions on Antennas and Propagation*, 2011.
17. Sharul Abdul Rahim, Sh Danesh, Uche Anicetus Okonkwo, Mursyidul Sabran, and Mohsen Khalily UWB monopole antenna with circular polarization Microwave and Optical Technology Letters, Vol. 54, 2012.
18. Mohsen Khalily, Mohamad Kamal A Rahim, Norasniza A Murad, Nor Asmawati Samsuri, Ahmed A Kishk Rectangular ring‐shaped dielectric resonator antenna for dual and wideband frequency Microwave and Optical Technology Letters, Vol. 55, 2013.
19. Mohsen Khalily, and Mohamad Kamal A Rahim A Novel Hybrid Design of Printed Hemi-Cylindrical Dielectric Resonator Monopole Antenna with Multibands Operation Progress In Electromagnetics Research C, Vol. 15, 2010.

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