

Design of Dual Band Rectangular Patch Antenna for S-band and C-Band Applications

Jyoti Jain, Abha Sharma

Abstract— A probe feed rectangular patch antenna is designed, simulated, fabricated and measured. The fabricated antenna operates at the frequency band 2.49 GHz (S-Band) and 5.03 GHz (C-Band). Experimental and simulation results of probe-fed rectangular patch antenna are presented and compared. To achieve dual band characteristics the position of the probe is optimized. Experimental results suggest that the proposed antenna can be used for Wi-Fi and WLAN applications.

Index Terms—Dual Band, Rectangular Patch Antenna, Wi-Fi, WLAN.

I. INTRODUCTION

Rectangular patch antenna is popular in patch antenna design. The rectangular patch antenna design is simple and convenient to fabricate [1]. The effect of the probe position in pentagonal and hexagonal patch antenna was reported in [2]. The rectangular patch antenna was deeply analyzed and found that the bandwidth is greater than circular patch antenna [3]. The hexagonal patch antenna for WLAN at 5.5 GHz with a bandwidth of 400 MHz was reported [4].

A dual band patch antenna was proposed to cover wireless local area network (WLAN) band at 2.4 and 5.2 GHz using U-slot in the ground [5]. The dual band patch antenna for 3.6 GHz and 5.2 GHz was designed with filtering performance and harmonic suppression [6]. The techniques discussed in above literature can be used to design dual band rectangular patch antenna.

This paper presents a rectangular patch antenna design with dual band characteristics. Electromagnetic simulation software is used to find the optimum position of feed and to achieve dual band characteristics. The second section of the paper deal with the design of the rectangular patch antenna. The simulated results such as scattering characteristics of probe-fed rectangular patch antenna are studied, analyzed and compared with experimental results in the third section of the paper. The impedance analysis helps in the verification of dual band characteristics of the proposed rectangular patch antenna. The impedance analysis is concluded in the last section of the paper.

II. ANTENNA DESIGN

The layout of probe-fed rectangular patch antenna is shown

in Fig. 1. The proposed antenna is designed and optimized for dual band i.e. 2.45 GHz (S-Band) and 4.9 GHz (C-Band) respectively using simulation software. The FR-4 substrate ($\epsilon_r = 4.3$) with dimension 50 mm \times 50 mm \times 1.6 mm is used to hold the rectangular patch with dimension 28.28 mm \times 28.28 mm. The ground plane dimensions are 40 mm \times 40 mm. The probe is used to directly feed the proposed antenna. The coaxial probe has an inner conductor radius of 0.62 mm. The probe position was earlier optimized in [1]. The optimum distance of the feed from the origin along the x-axis is 8 mm. The techniques to achieve the optimum feed point was discussed in [7].

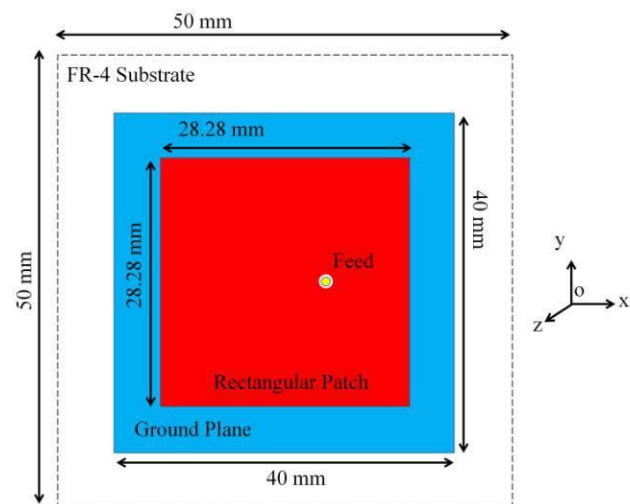


Fig. 1: Layout of the proposed rectangular patch antenna with dimensions.

III. RESULTS AND DISCUSSION

The proposed rectangular patch antenna is fabricated on FR-4 substrate as shown in Fig. 2. To study the effect of proposed antenna geometry on reflection coefficient (S_{11}), voltage standing wave ratio (VSWR), impedance (Z_{11}), the simulated results are analyzed. The impedance analysis is used to verify the dual band characteristics of the proposed antenna. The impedance analysis compares the simulation results with the experimentally measured results.

Jyoti Jain, Department of Electronics & Communication Engineering, Rajasthan College of Engineering for Women, Rajasthan, India.

Abha Sharma, Department of Electronics & Communication Engineering, Rajasthan College of Engineering for Women, Rajasthan, India.

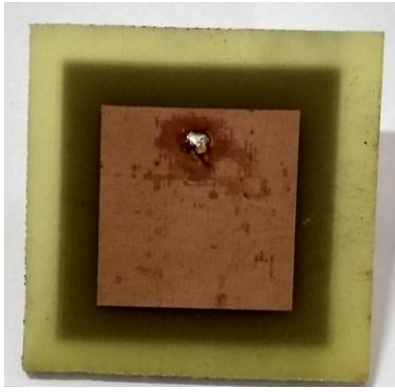


Fig. 2: Proposed fabricated antenna.

A. Reflection coefficient

The reflection coefficient of the proposed antenna is sensitive to the dimension of the rectangular patch. The reflection coefficient of the proposed antenna is measured using vector network analyzer (VNA). The simulation results from electromagnetic simulation software are compared with measured results as shown in Fig. 3. The simulation result shows a band from 2.38 to 2.52 GHz (~140 MHz) for the S-Band and 4.79 to 5 GHz (~210 MHz) for the C-Band. The measured reflection coefficient results shows band from 2.47 to 2.53 GHz (~ 64 MHz) for the S-Band and 4.95 to 5.11 GHz (~ 163 MHz) for the C-Band as shown in Fig. 3.

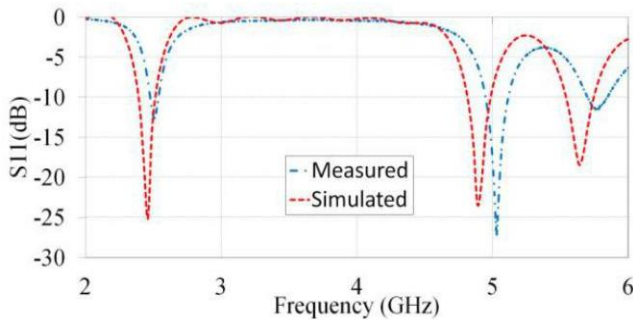


Fig. 3: Measured Reflection coefficient of the proposed antenna.

B. Voltage Standing Wave Ratio

The VSWR should be less than two for the patch antenna. According to simulation results, the first frequency at 2.45 GHz has VSWR = 1.11 and the second frequency at 4.9 GHz has VSWR = 1.17, while the measured results show the value of VSWR as 1.60 and 1.09 for the frequency 2.49 GHz and 5.03 GHz.

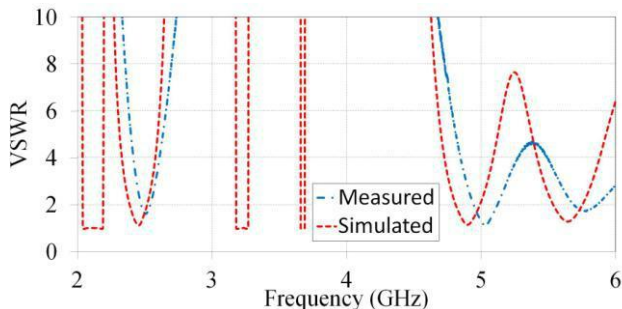


Fig 4: Measured VSWR of the proposed antenna.

C. Impedance

The impedance of the patch antenna should be matched to the impedance of the coaxial feed. The simulation results of impedance show the value of $50.58 - 4.21j \Omega$ and $53.67 - 4.8j \Omega$ at 2.45 GHz and 4.9 GHz respectively while the measured result shows value $53.54 - 27j \Omega$ and $46.32 + 2.49j \Omega$ at 2.49GHz and 5.03 GHz respectively as shown in Fig. 5 and Fig. 6 respectively.

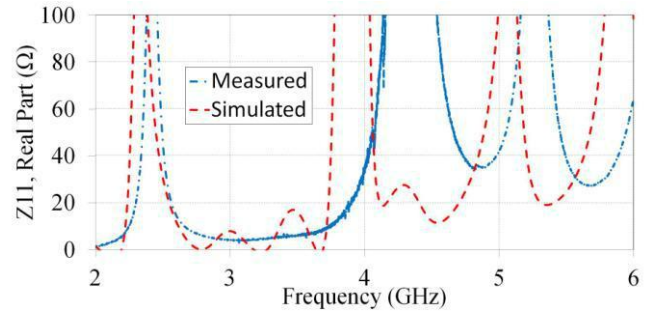


Fig 5: Measured impedance (real part) of the proposed antenna.

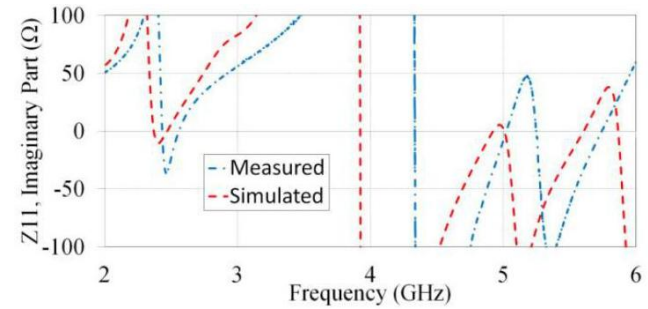


Fig. 6: Measured impedance (imaginary part) of the proposed antenna.

III. CONCLUSION

The effect of probe position on rectangular patch antenna to achieve dual band i.e. S-Band (2.49 GHz) and C-band (5.03 GHz) is studied and analyzed experimentally. The impedance measured at 2.49 GHz and 5.03 GHz are $53.54 - 27j \Omega$ and $46.32 + 2.49j \Omega$ respectively. The experimental impedance analysis suggests that antenna has dual band characteristics and can be implemented in Wi-Fi and WLAN applications.

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Jyoti Jain received the B. Tech degree in Electronics & Communication Engineering from Suresh Gyan Vihar University, Jaipur, in 2012 and pursuing M. Tech final year in Digital Communication from Rajasthan College of Engineering for Women, Jaipur. She published a paper titled "Dual Band Rectangular Microstrip Patch Antenna design for RF energy harvesting" in International conference on Optical & Wireless Communication Technologies (OWT-2017), MNIT, Jaipur, India.



Abha Sharma received the B. E. degree in Electronics & Communication Engineering from Rajasthan University, Jaipur, in 2007 and the M. Tech degree in Digital communication from SKIT, Rajasthan Technical University, Kota, India, in 2014. Currently she is working as an Assistant Professor in Rajasthan College of Engineering for Women, Jaipur, India since 2013. She has more than seven years of teaching experience in the field of antennas. She is also a member of IAENG from 2015. She is the author of various conference papers. Her research interests include microstrip antennas, ultra wideband antennas and band reject antennas