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

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***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 ($\varepsilon r = 4.3$) with dimension 50 mm × 50 mm × 1.6 mm is used to hold the rectangular patch with dimension 28.28 mm × 28.28 mm. The ground plane dimensions are 40 mm × 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].

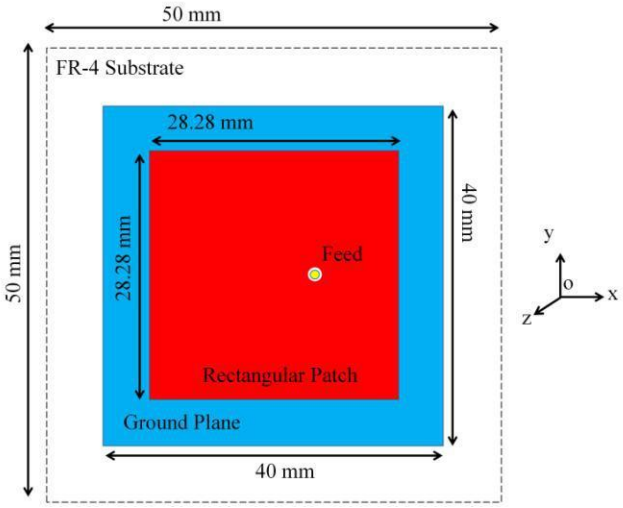

Fig. 1: Layout of the proposed rectangular patch antenna with dimensions.

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 (S11), voltage standing wave ratio (VSWR), impedance (Z11), 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.

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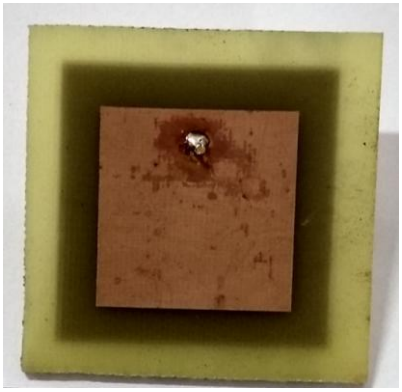

Fig. 2: Proposed fabricated antenna.

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.

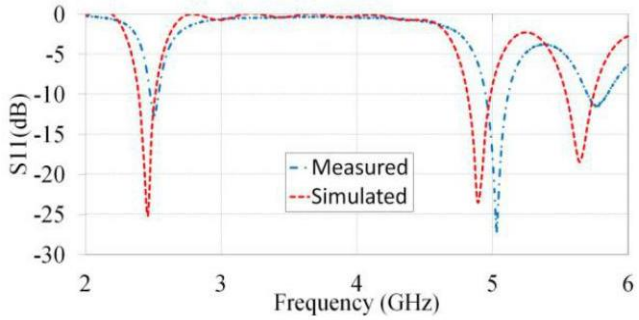

Fig. 3: Measured Reflection coefficient of the proposed antenna.

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.

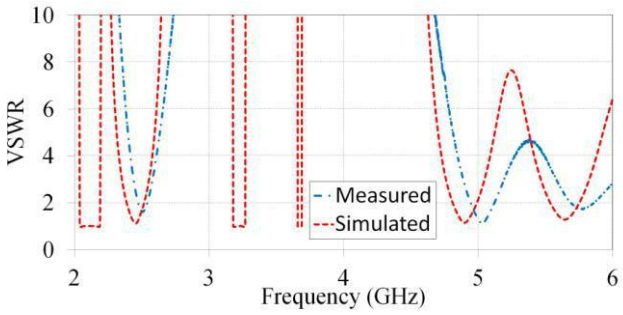

Fig 4: Measured VSWR of the proposed antenna.

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 Ω and 53.67 - 4.8j Ω at 2.45 GHz and 4.9 GHz respectively while the measured result shows value 53.54 - 27j Ω and 46.32 + 2.49j Ω at 2.49GHz and 5.03 GHz respectively as shown in Fig. 5 and Fig. 6 respectively.

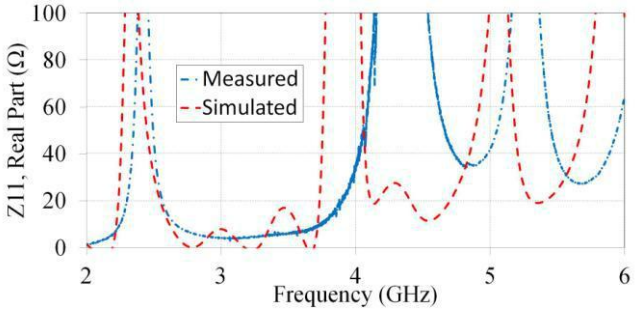

Fig 5:.Measured impedance (real part) of the proposed antenna.

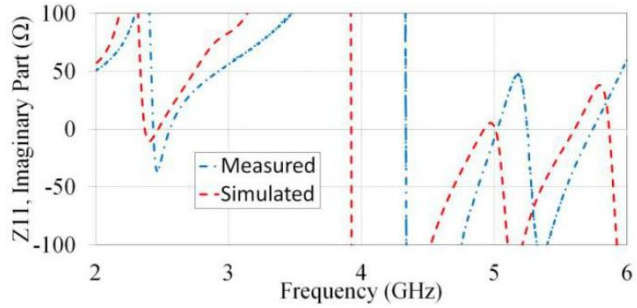

Fig. 6: Measured impedance (imaginary part) of the proposed antenna.

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 Ω and 46.32 + 2.49j Ω 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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