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Design of Slotted Microstrip Patch Antenna for WLAN application

Anita R
Associate Professor
Dept of ECE, EPCET

Jayanthi Kumari T R
Professor
Dept of ECE, EPCET

Abstract: This paper discusses the design of rectangular microstrip patch antenna with dual band (2.4GHz & 3.6 GHz) for WLAN application with rectangular slot and circular slot. The rectangular microstrip antenna operates at 2.4 GHz and
GHz which is used for 802.11b/g/n and 802.11y WLAN channels respectively. The antenna is simulated using CST microwave studio and the performance of the antenna is measured in terms of return loss, VSWR and gain. The simulated results confirm the successful design using 50 ohm inset fed microstrip antenna for WLAN application.
Key words: Slot loaded, dual band, 50 ohm inset fed line, CST microwave studio, gain and return loss.

I. INTRODUCTION

The recent development in communication system such as GPS, WLAN , satellite communication and wireless communication often require antenna with compact size , low cost, ease of construction and capable of operating more than one band of frequency[1]. This technique is focused much into the design of microstrip patch antenna. The patch antennas have advantages like low profile, light weight, simple and inexpensive to fabricate. The disadvantages of microstrip patch antenna are narrow frequency, band width and low efficiency. In order to overcome the disadvantage of narrow bandwidth, several techniques are employed. By incorporating a slot, the bandwidth can be increased. In this work, a rectangular slot and a circular slot is designed which operates in dual frequency. Dual frequency operation is necessary in wireless communication for application such as GPS, WLAN etc. [2]. The dual frequency antenna (2.4GHz& 3.6GHz) is achieved by introducing rectangular slot and circular slot on the patch. The substrate used for the design of rectangular microstrip patch antenna is glass epoxy FR4 substrate with dielectric constant εr =4.4. The proposed slot antenna is fed by 50 ohm inset feed line.

II. MICROSTRIP ANTENNA DESIGN

The substrate used for the design of rectangular microstrip patch antenna is glass epoxy FR4 substrate with dielectric constant εr =4.4 for designing the microstrip patch antenna, the length and width are calculated as given by

$W = [c / ((\varepsilon r+1)/2)-1/2] / 2fo$ (1)

C=velocity of light, εr =dielectric constant of substrate, fo=resonance frequency, w=width.

The length of the patch:

$L = [c / (2fo (\varepsilon reff)-1/2)] -2\Delta L$ (2)

Where,

$\varepsilon reff = (\varepsilon r+1) / 2 + ((\varepsilon r-1) / 2) [(1+12h)/W]-1/2$ (3)

h=height of the substrate and ,

$\Delta L = 0.412h [(\varepsilon reff+0.300)(W/h +0.264)] /[(\varepsilon reff-0.258) (W/h +0.800)]$ (4)

The length and the width of the ground plane

$Lg=6h+L$ (5)

$Wg=6h+W$ (6)

III. ANTENNA DESIGN SPECIFICATION

The substrate used is glass epoxy FR4 with dielectric constant εr =4 4. Height of the dielectric substrate is 1.575
and loss tangent tanδ is 0.002. Antenna is fed through 50 ohm inset feed line. Simulation is done using CST microwave studio.
Geometry of proposed microstrip antenna

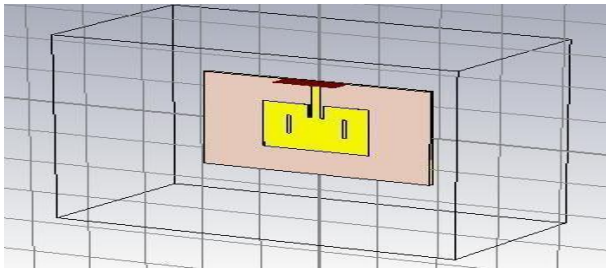
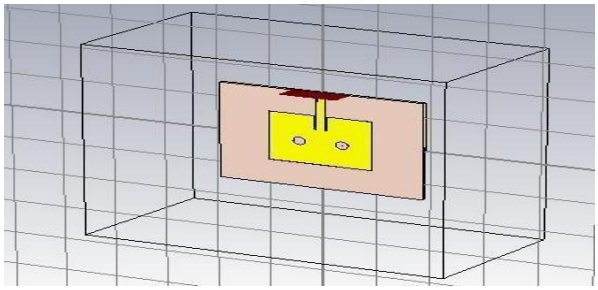


Figure 1: Structure view of rectangular slot antenna
Dimension of rectangular slot antenna
Ground size=58.90x76.07 Substrate size=58.90x76.07 Patch size= 29x35.4
Slot size=11x1.2 Dielectric constant =4.4



Figuer 2: Structure of circular slot antenna

Dimension of circular slot antenna Ground size=58x76
Substrate size=58x76 Patch size=28.6x38.2 Slot size=2.85 Dielectric constant =4.4

IV. SIMULATED RESULTS

The designed antenna resonates at two different frequencies 2.4GHz and 3.6GHz can be used for WLAN application. The simulated return loss, VSWR, radiation pattern and smith chart of the dual band rectangular slot microstrip antenna is shown in figure 1a to 1e respectively.

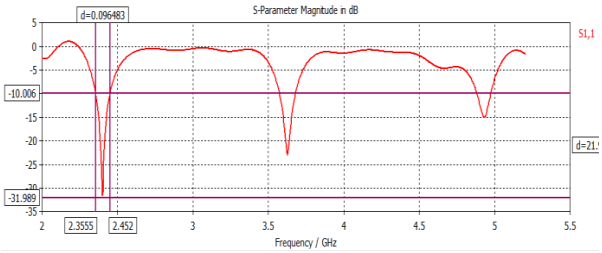


Figure: 1a Simulated return loss of the dual band rectangular slot microstrip patch antenna

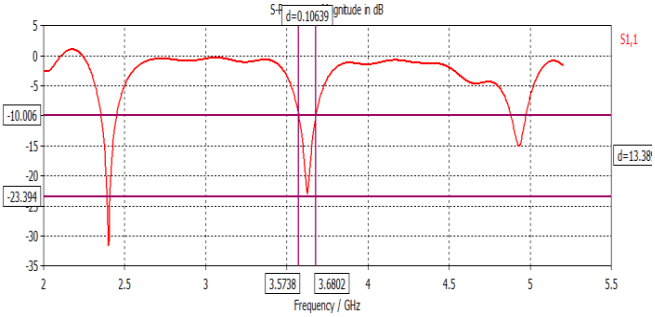


Figure: 1b Simulated return loss of the dual band rectangular slot microstrip patch antenna

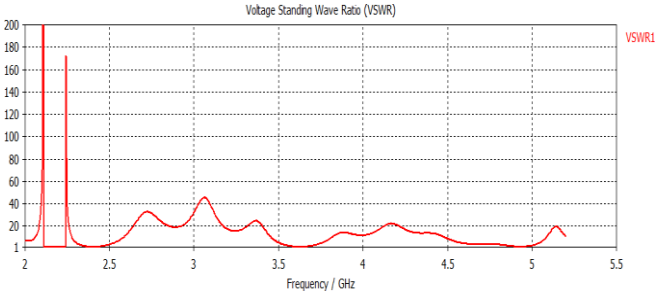


Figure: 1c VSWR of the dual band rectangular slot microstrip patch antenna

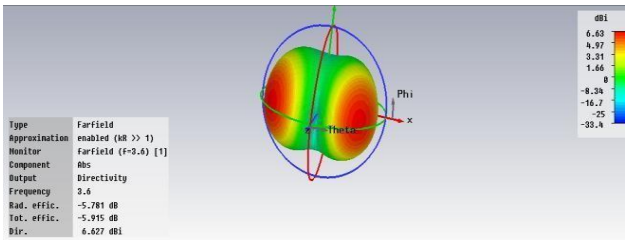


Figure: 1d Radiation pattern of the dual band rectangular slot microstrip patch antenna

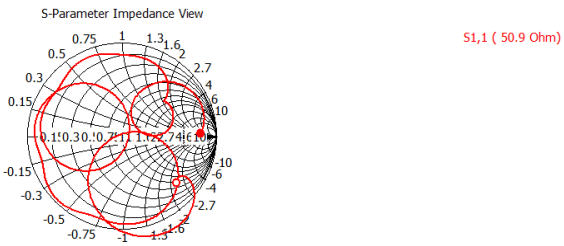


Figure: 1e Smith chart of the dual band rectangular slot microstrip patch antenna

The simulated return loss, VSWR, radiation pattern and smith chart of the dual band circular slot microstrip patch antenna is shown in figure 2a to figure 2e respectively.

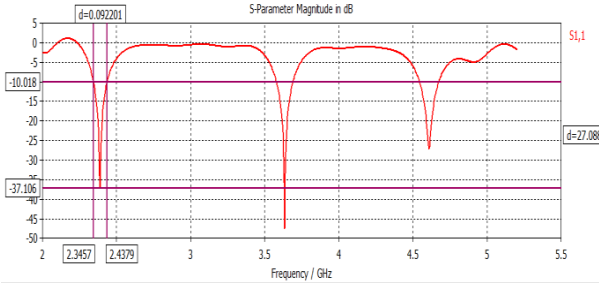


Figure: 2a Simulated return loss of the dual band circular slot microstrip patch antenna

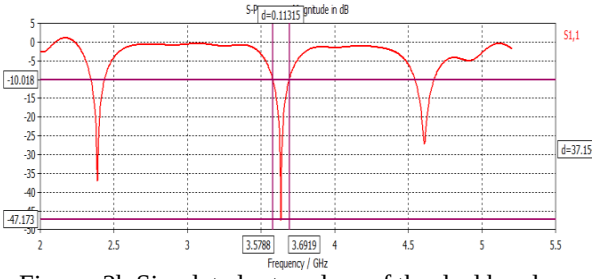


Figure: 2b Simulated return loss of the dual band circular slot microstrip patch antenna

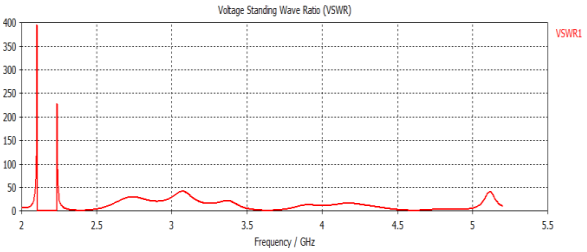


Figure: 2c VSWR of the dual band circular slot microstrip patch antenna

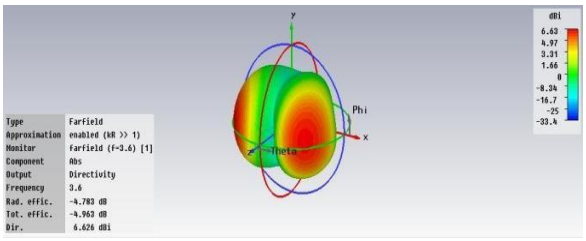


Figure: 2d Radiation pattern of the dual band circular slot microstrip patch antenna

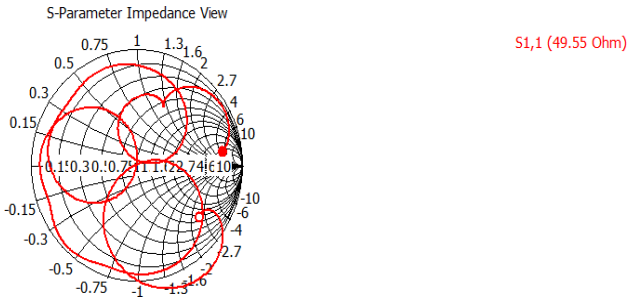


Figure: 2e Smith chart of the dual band circular slot microstrip patch antenna

Table: 1 Antenna comparison of parameters for the designed microstrip

Patch	Frequency GHz	Return loss dB	Bandwidth MHz	VSWR
Patch with circular slot	2.4	-37.10	92	1.02
	3.6	-47.13	113	1.001
Patch with rectangular slot	2.4	-31.83	96.48	1.05
	3.6	-23	106.1	1.15

RESULTS AND DISCUSSION RETURN LOSS

The return loss obtained for rectangular slot microstrip patch antenna is -31.83dB and -23dB and for circular patch antenna is -37.10dB and -47.13dB

BAND WIDTH

The band width obtained for rectangular slot microstrip patch antenna is 96.48MHz and 106.1MHz and for circular slot microstrip patch antenna is 92MHz and 113MHz.

V. CONCLUSION

The dual band microstrip patch antenna width rectangular and circular slot antenna has been designed and simulated using CST studio which fulfills the band width requirements for WLAN application. The results obtained show that the antenna can be operated at 2.4GHZ & 3.6GHz frequency band. The performance of the antenna in terms of VSWR band width, return loss is compared with the existing designs and there is an improvement in gain and band width of the antenna. The gain of the rectangular slot antenna is 6.43dB and gain of circular slot antenna is 6.63dB.

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