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DESIGN RECTANGULAR PATCH ANTENNA OF A DUAL-BAND BY USING DIFFERENT SLOTS FOR WIRELESS SYSTEMS

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ABSTRACT

Microstrip patch antenna with a dual-band operating at 2.4 GHz and 5.8 GHz was designed. A dual-band operation is achieved by loading the antenna with different slots. Similar radiation characteristics were at both bands of operation. Also two operating bands covering (2.3573-2.4476) GHz, (5.5785-5.9653) GHz can be achieved. The results obtained by (CST-2010) software package. This antenna is fed by a coaxial probe feeding. The antenna has a directivity of 6.31dBi and 8.69dBi, respectively.

Keywords: microstrip antenna, wireless systems, dual-band, different slots.

1. INTRODUCTION

Microstrip antennas have widely applied in telecommunication systems because of their attractive features, such as low profile, light weight, compactness and low cost, allow multi-frequency operation to be achieved [1]. People have proposed many kinds of methods to meet the dual-band operation demands of 2.4 GHz and 5 GHz is easy to generate multi-resonance by simply varying the slot width and shape, it has received much attention recently [2] - [3]. the dual-band operations can be obtained by embedding L or U-shape slots in single-layer patch [4]. This paper presents the use of transmission line method to analysis the rectangular patch antenna. RMPA operating of resonance frequency 2.4 GHz, with coaxial probe feed used. The directivity of an antenna is defined as the ratio of the radiation intensity in a given direction from the antenna to the radiation intensity averaged over all directions [5].

2. DESIGN OF SINGLE PATCH AND SLOTS DIMENSIONS

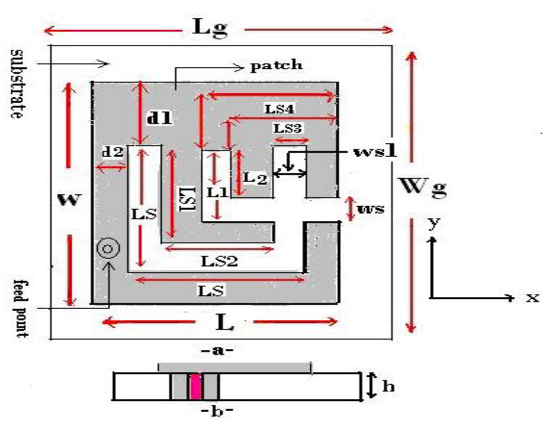

Figure-1. Designed antenna for different slots (a) front side (b) bottom side.

The dual-band MPA is designed for WLAN application at 2.4 GHz and 5.8 GHz. first the RMPA was designed and then different slots were used in the patch. From Figure-1 it is seen that U-shape slot with dimensions (Ls, Ls1, and Ls2) mm, ws1 slot width. Then Ls is the vertical and horizontal slot length, Ls is equal in both arms of the slot, in the bottom slot also, Ls1 and Ls2 are slots lengths in the vertical and horizontal respectively, and the slot width is equal over all slot. Then L-shaped slot cut in the right arm of U-shaped slot with dimensions (L1,L2,Ls3, and Ls4) mm, ws slot width, and the width is equal in the vertical and horizontal of the slot. A FR4 substrate ε_r = 4.6 with tangent loss = 0.025 and the height of the substrate h = 3mm. f_o resonance frequency = 2.4 GHz, the input impedance of 50 ohms, the software used to model and simulated the RMPA is the (CST-2010), meshcell = 192, 096. The width and length of the patch are given by [6] - [7].

$$W = \frac{c}{2 f_o \sqrt{\frac{\varepsilon_r + 1}{2}}} \tag{1}$$

$$L = L_{eff} - 2\Delta L \tag{2}$$

the effective dielectric constant ε_{eff} is given as:

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \sqrt{\frac{1}{\left[1 + 12\frac{h}{w}\right]}} \tag{3}$$

And a distance (Δ L), which is given by [8]:

$$\Delta L = 0.412h \frac{\left(\varepsilon_{eff} + 0.3\right)\left(\frac{w}{h} + 0.264\right)}{\left(\varepsilon_{eff} - 0.258\right)\left(\frac{w}{h} + 0.813\right)} \tag{4}$$

Where, c is the velocity of light, ε_r is the dielectric constant of substrate, f_o is the resonance frequency. The

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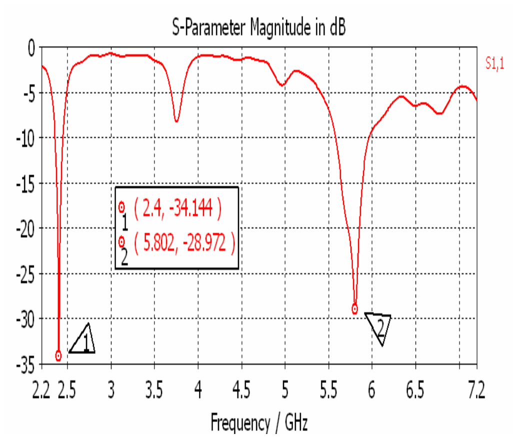
width of equation (1) gives w = 37.3mm, the length of equation (2) gives L = 28.202mm. After final optimization process, the final optimum parameters for RMPA were obtained where the width and length are found 37mm and 29.3mm, respectively.

3. SIMULATION RESULTS



Fiqure-2. Return loss for designed antenna.

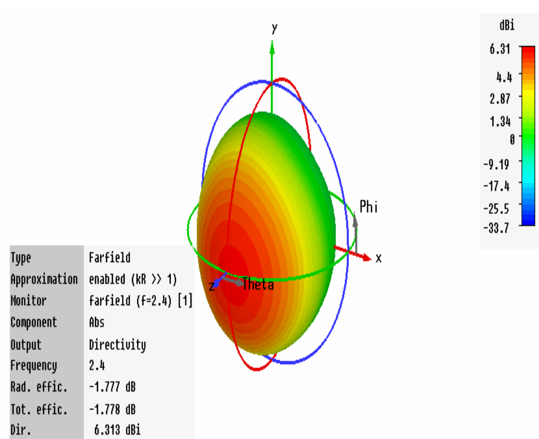


Figure-3. 3D plot directivity at f = 2.4GHz.

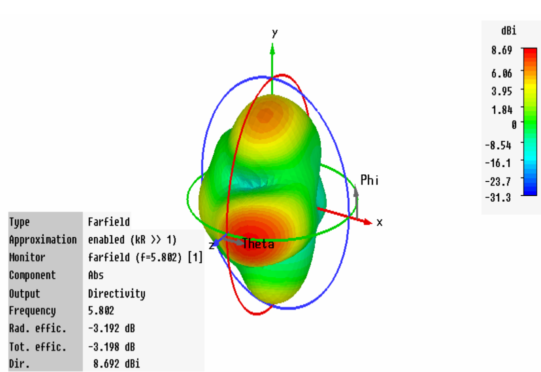
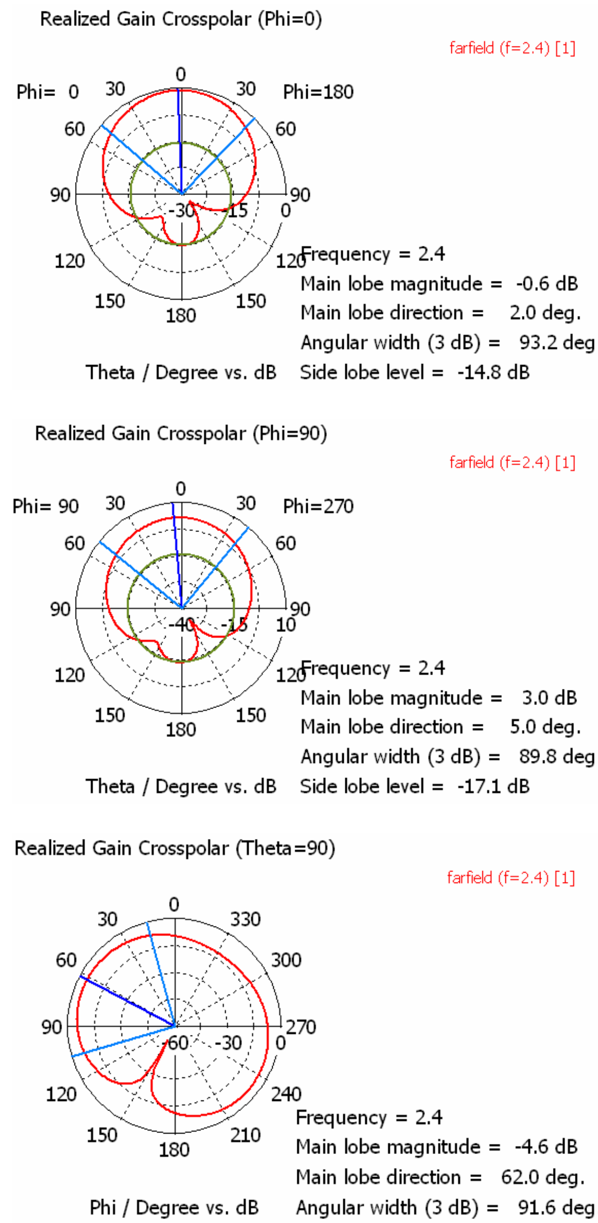
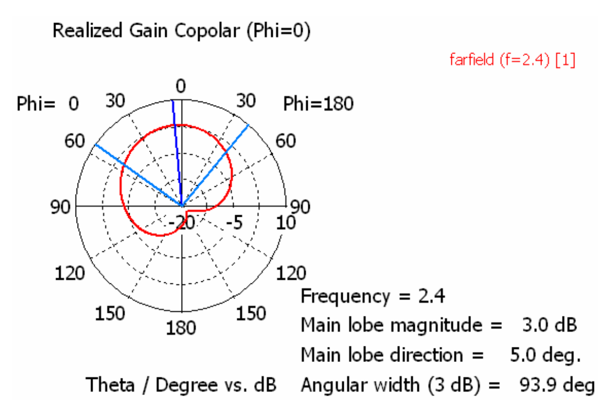


Figure-4. 3D plot directivity at f = 5.802GHz.



(a) crosspolar



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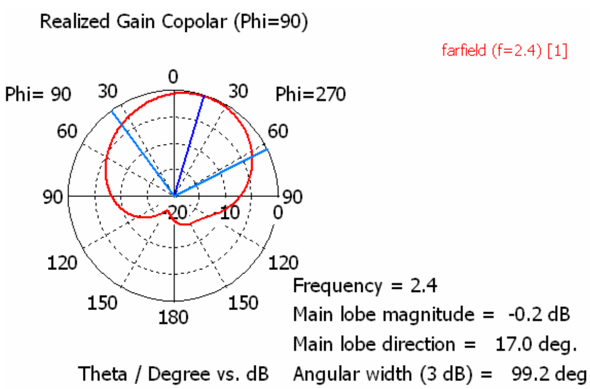
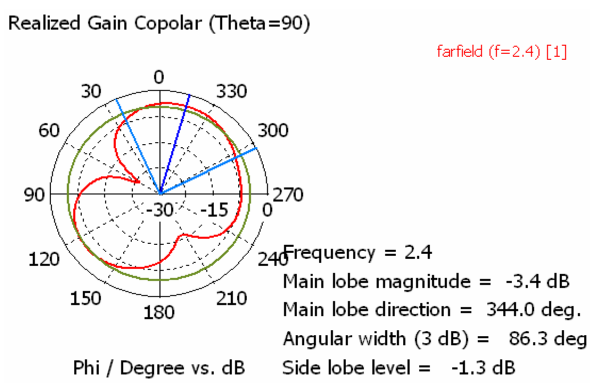
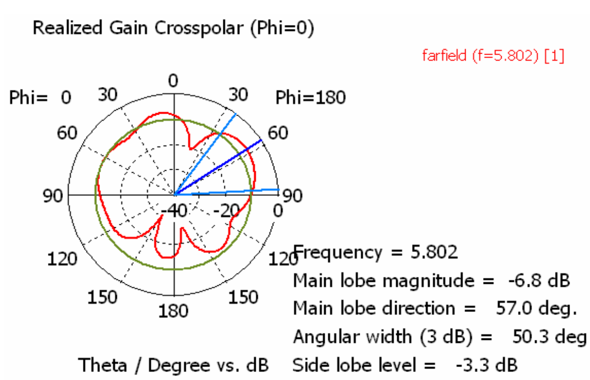
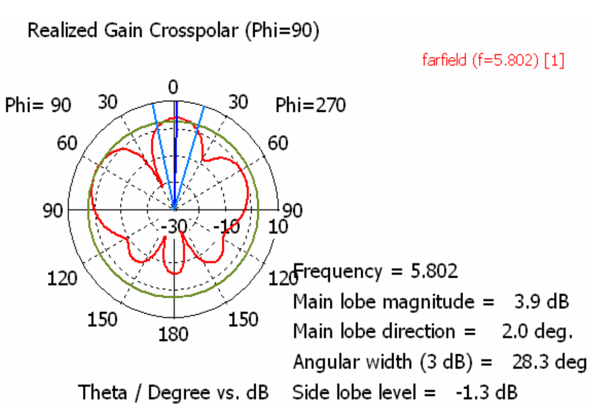


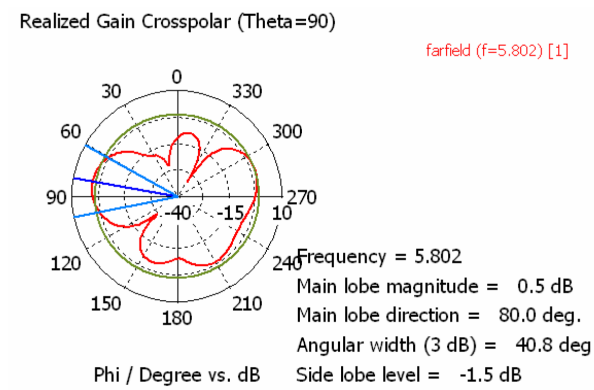


(b) copolar

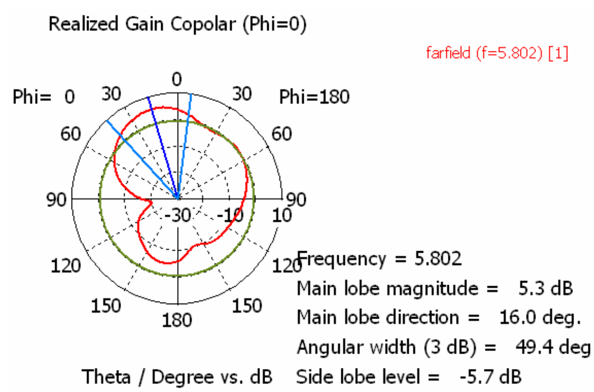
Figure-5. Radiation pattern at f =2.4GHZ (a) crosspolar (b) copolar.

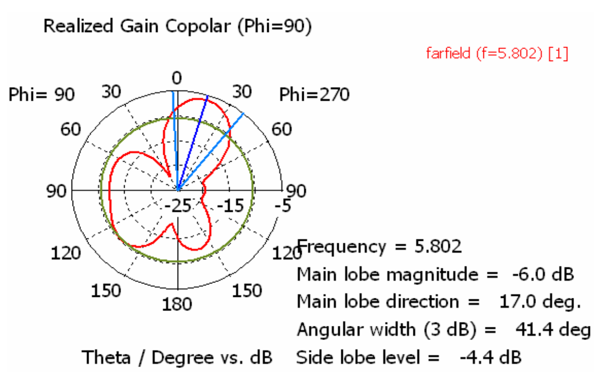


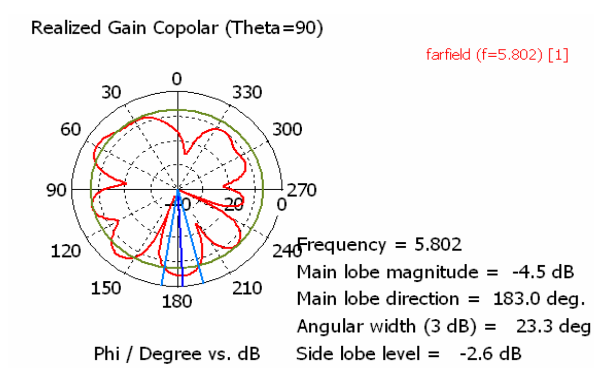




(a) crosspolar







(b) copolar

Figure-6. Radiation pattern at f = 5.802 GHz (a) crosspolar (b) copolar.

Figure-2 shows the return loss for propose antenna, it is clearly seen that dual impedance bandwidth (-10dB) return loss of (90.3) MHz of lower band (2.3573-2.4476) GHz and (386.8) MHz of higher band (5.5785-5.9653) GHz. And from this simulation results we can see good frequency coverage for both 2.4 GHz and 5.8 GHz WLAN bands. The radiation patterns in the lower and higher bands are also plotted in Figure-5 and Figure-6. It is observed that the two bands have similar radiation characteristics.

Table-1. Design specification for a dual-band rectangular patch antenna.

Parameters	Value
Operating frequency	2.4 GHz and 5.8 GHz
Dielectric constant of the substrate	FR4 with ε_r = 4.6
Height of dielectric substrate	h = 3mm
Loss tangent (δ)	0.025
Location of feed point (x_f, y_f)	(-8.35, 7.8)
Length of the patch	L = 29.3mm
Width of the patch	W = 37mm

Table-2. Slots dimensions for designed antenna.

Parameters	Value
L-slot lengths (L1×L2×Ls3×Ls4) mm	(7.65×5.65×4.65×6.65) mm
L-slot width	Ws = 2mm
U-slot lengths (Ls×Ls1×Ls2)mm	(17.445×14.845×12.245)
Location of U-slot(x1, y1)	(-4, 0.8)
U-slot width(ws1)	Ws1 = 2.6mm
Location of L-slot(x2, y2)	(8, 7.5)
The distance of top and left edge respectively for U-slot	d1 = 0.225mm and d2 = 9.9275mm

Table-3. Parameters designed antenna with different slots.

Parameters	Value
Bandwidth of lower band at 2.4GHz	BW1 = 90.3 MHz
Bandwidth of higher band at 5.802 GHz	BW2 = 386.8 MHz
Return loss for lower band	-34.144dB
Return loss for higher band	-28.972dB
Directivity of lower band at 2.4GHz	Dir = 6.31dBi
Directivity of higher band at 5.802GHz	Dir = 8.69dBi

4. CONCLUSIONS

In this paper, different-shaped slots antenna for a dual-band is proposed and investigated, the antenna fed by 50 ohms, a coaxial feed. From simulation results we can see good frequency coverage for both 2.4 GHz and 5.8 GHz WLAN bands. Avery good agreement has been obtained for all results.

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