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DUAL-BAND OF A PROBE FED RECTANGULAR PATCH ANTENNA USING U-SHAPED SLOT FOR WLAN APPLICATION

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ABSTRACT

A dual-band microstrip patch antenna is presented in this paper. Dual- band operation is achieved by loading the antenna with U-shaped slot. The proposed antenna can excite resonance at the (2.4) GHZ and (5.823) GHZ bands with impedance band widths of 53.5 MHZ (2.3749-2.4284 GHZ), 945.6 MHZ (5.6627-6.6083GHZ). Computer simulation technology (CST-2010) Software Package is used to compute the radiation pattern and S_{11} of the antenna. The gains are (4.54) and (4.94) dB, respectively over the two operating bands.

Keywords: WLAN application, dual-band, probe fed, U-slot patch antenna.

1. INTRODUCTION

The development of wireless local area networks (WLAN) represented one of the principal interests in the information and communication field. Thus, the current trend in government communication systems has been to develop low cost, minimal weight, low profile antennas that are capable of maintaining height performance over a large spectrum of frequencies. This technological trend has focused much effort into the design of microstrip patch Antenna as [1]. The most popular technique for obtaining a dual- frequency behavior is to introduce a reaction loading to a single patch including slots [2] - [3]. In this paper with inspiration of the technique, a probe fed patch antenna with a U- shaped slot was presented [4]. In this design, we assume the left and right sides of symmetric U-slot patch antenna has enough effective role in Antenna structure to produce dual- Band. Generally, the dual- band operation can be obtained by multilayer stacked patches or by embedding L or U- shape slots in single-layer patch [5]. Three methods of analysis are commonly used to calculate microstrip antenna parameters [6]. These are transmission line model, cavity model, and full wave analysis. This paper presents the use of transmission line method to analysis the rectangular patch Antenna. RMPA operating of resonance frequency (2.4 GHz) for TM10 mode, with coaxial probe feed used.

2. PROPOSED ANTENNA GEOMETRY AND DESIGN

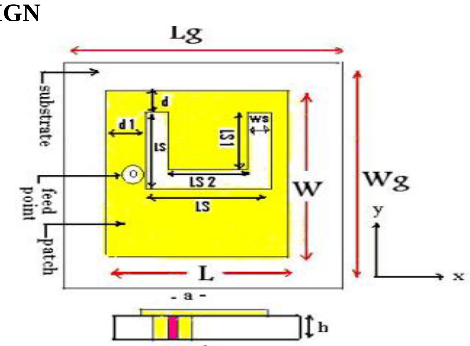

Figure-1. Geometry of proposed antenna with U-shaped slot (a) front side (b) bottom side.

The basic U-slot rectangular patch Antenna design is seen in Figure-1. L is the patch Length, W is the patch width, Ls is the vertical and horizontal slot length, (Ls) is equal in both arms of the slot, so in the bottom slot also, Ls1 and Ls2 are slot lengths in the vertical and horizontal, respectively, (d) and (d1) the distance of top and left edge of the patch respectively, there is a 1 mm thick air layer and then, a FR4 substrate ε_r = 4.6 with tangent loss = 0.025 and thickness (h) of 3 mm, of resonance frequency = 2.4 GHZ the width and length of the patch are given by [7] [8].

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

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

And 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 [9]:

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

Where, C is the velocity of light, ε_r is the dielectric constant of substrate, (f_o) is the antenna working frequency. The width of the equation (1) gives, W = 37.3 mm then the length of the equation (2) gives, L = 28.202 mm. after going through with the optimization process the final optimization process, the final optimum parameters for the rectangular microstrip patch antenna were obtained where the width and length are found (37.33) mm and

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(30.5) mm, respectively. The input impedance of 50 ohms, the software used to model and simulated the RMPA is the (CST-2010) package, mesh cells = 187.968.

3. SIMULATION RESULTS

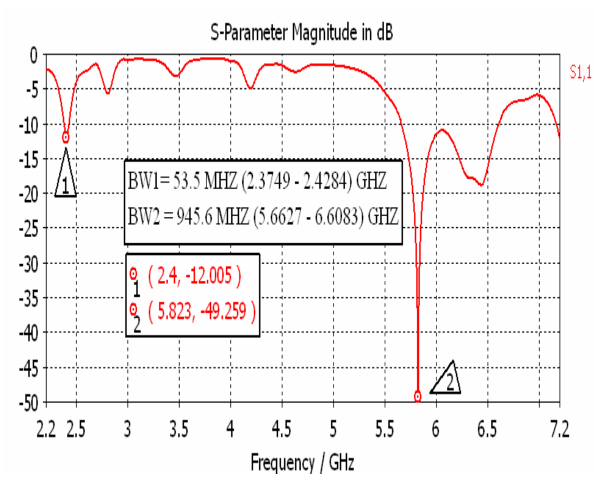


Figure-2. Returns loss for proposed Antenna.

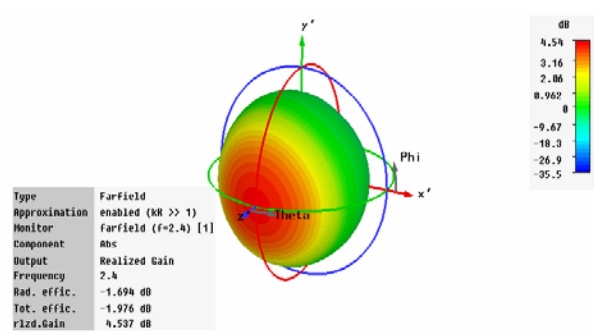


Figure-3. 3D radiation pattern of antenna at f = 2.4 GHZ.

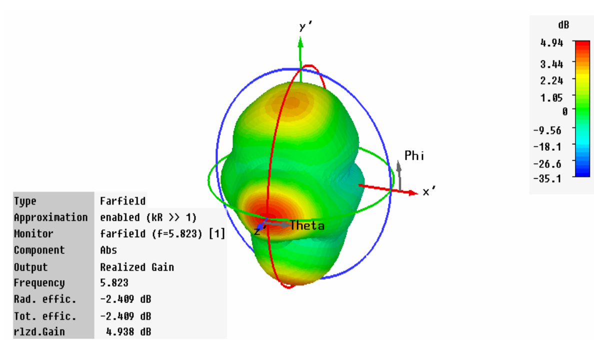
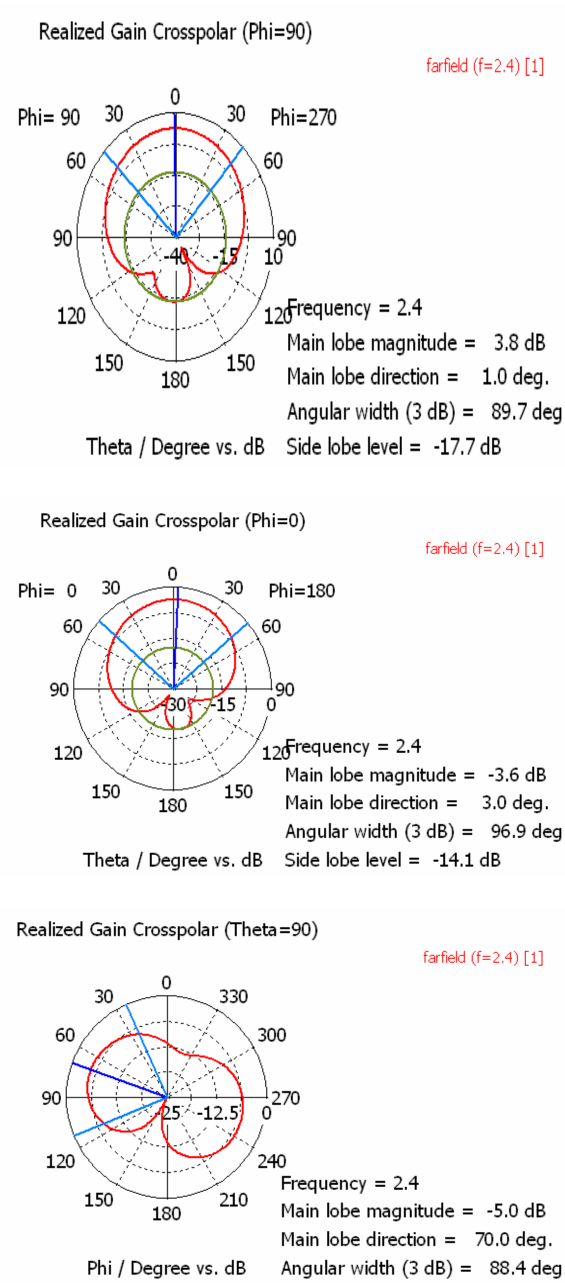
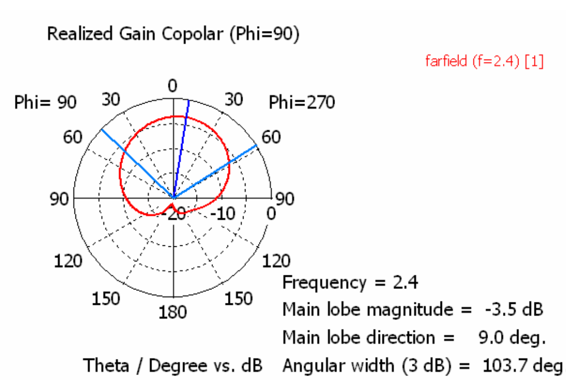


Figure-4. 3D radiation pattern of antenna at f =5.823GHZ.



(a) crosspolar



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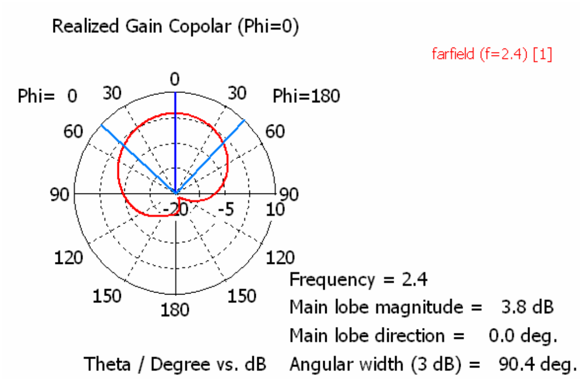
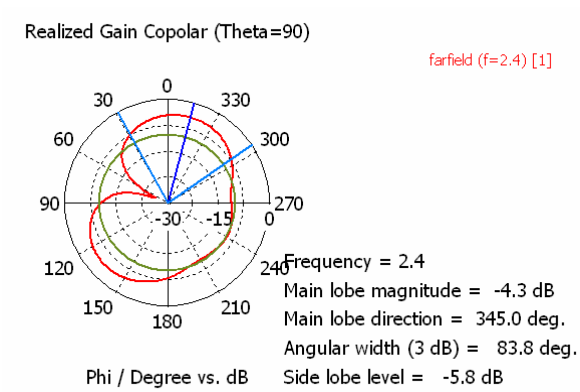
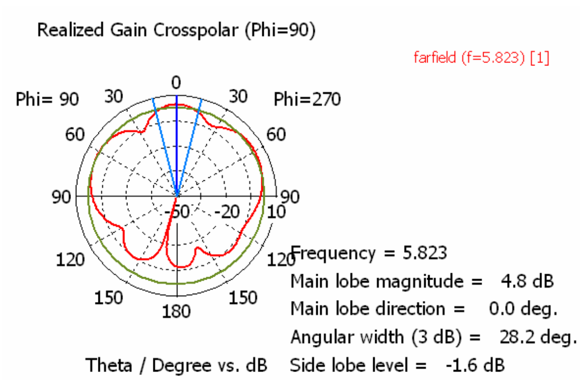
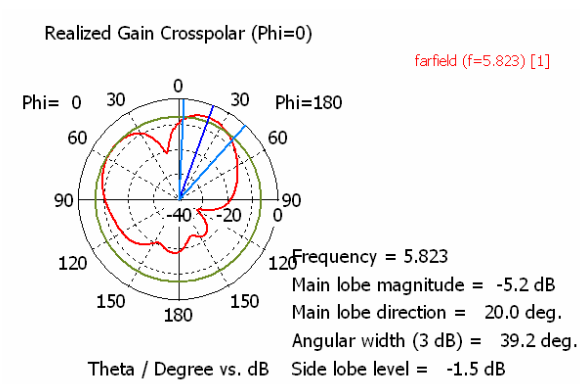


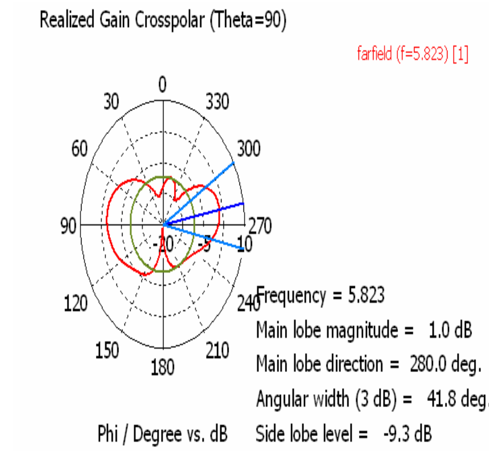


(b) copolar

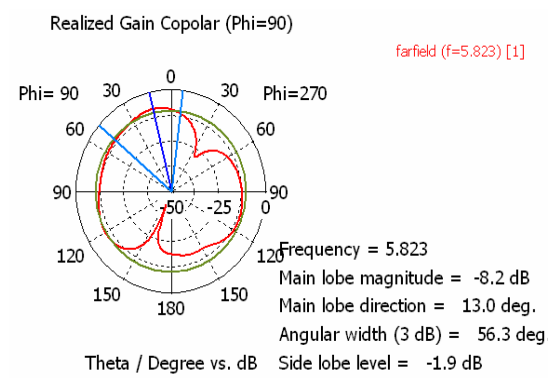
Figure-5. Radiation pattern for antenna at f = 2.4 GHZ.

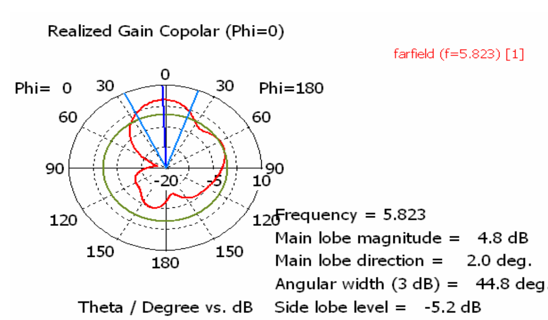


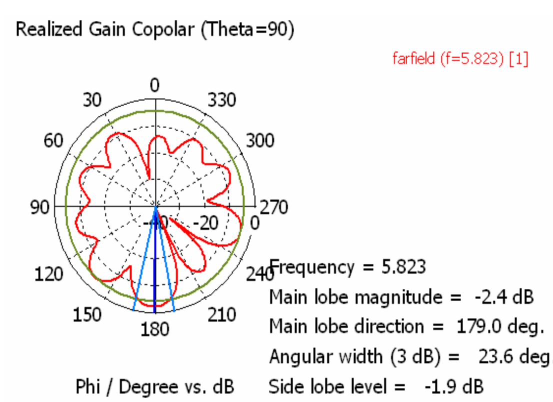




(a) crosspolar







(b) copolar

Figure-6. Radiation pattern for antenna at f =5.823 GHZ.

As seen from the simulation results especially the Figure-2, it can tell us that this antenna will get resonance at 2.4 GHZ and 5.823 GHZ for lower and higher bandwidth respectively, then shows simulated frequency response of return loss for the proposed antenna, it is clearly seen that dual impedance bandwidth (-10 dB) return loss of 53.5 MHZ of lower band (2.3749-2.4284) GHz, and 945.6 MHZ of Broadband (5.6627-6.6083) GHZ, that meets the requirement of the bandwidth for the WALN 2.4 GHZ and 5.8 GHZ.

Table-1. Characteristics of conventional rectangular antenna.

Parameters	value
operating frequency	2.4 GHZ
Dielectric constant	FR4, $\varepsilon_r = 4.6$
Loss tangent (tan δ)	0.025
Thickness of the substrate	h =3mm
Length of the patch	L=30.5mm
Width of the patch	W =37.33mm
Location of feed point (x_f, y_f)	(-8.1, 7.85)

Table-2. parameters proposed rectangular antenna with U-shaped slot.

Parameters	Value
Slots length (Ls×Ls1×Ls2) mm	(17.445×14.845×12.245) mm
Slot width (Ws)	Ws = 2.6 mm
Slot distance of top edge	d = 0.42 mm
Slot distance of left edge	d1 = 11.92 mm
Bandwidth of lower band at 2.4 GHZ	BW_1 = 53.5 MHZ with (-12.005) return loss
Bandwidth of higher band at 5.823 GHZ	BW_2 = 945.6 MHZ with (-49.256) return loss
Slot location (x1, y1)	(-5.4, 0.8)
Gain in dB for lower and higher band respectively	4.54 dB and 4.9 dB at f_1 = 2.4 and f_2 = 5.823 GHZ

4. CONCLUSIONS

The paper present design of dual- band probe fed rectangular patch antenna with U-shaped slot has been proposed and studied in this work, operating at 2.4 GHZ and 5.8 GHZ WLAN application, with two bands around (2.3749-2.4284) and (5.6627-6.6083) GHZ.

REFERENCES

[1] C.A. Balanis. 1982. Antenna Theory. 2nd Ed. John Wiley and sons, inc., New York, USA.

[2] S. Maci, G. Biffi Gentili and G. Avitabile. 1993. Single-Layer Dual- Frequency Patch Antenna. Electronics Letters. 29: 16.

[3] S. Maci, G. Biffi Gentili, P. Piazzesi and C. Salvador. 1995. A Dual Band Slot-Loaded Patch Antenna. IEE Proceedings H. 142, 3, March. pp. 225-232.

[4] Lee K. F., K. M. Luk, K. F. Tong, S. M. Shum, T. Huynh and R. Q. Lee. 1997. Experimental and simulation studies of the coaxially fed U-slot rectangular patch antenna. Inst. Elect. Eng. Proc. - Microw. Antennas Propagat. 144: 354-358, Oct.

[5] Jui-HanLu. 2003. Broadband Dual-frequency operation of circular patch Antenna as and Arrays with a pair of L-shaped slots [J]. IEEE Transaction on Antenna as and propagation. 51(5): 1018-1023.

[6] R. W. Dearnley. 1989. A Broadband Transmission Line Model for a Rectangular microstrip Antenna. IEEE Trans. Antennas and propagation. AP 37(1): 6-15, January.

[7] Bahl I.J. and Bharatia P. 1980. Microstrip Antennas, Artech House.

[8] David W. Green. 2002. Broadbanding of microstrip Antenna.

[9] James I.J and Hall P.s. 1989. Handbook of Microstrip Antennas. 1, peter pereggrinus Ltd.