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CPW-fed Quad Band Microstrip Antenna for Multiband Application

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ABSTRACT

We demonstrate Multi-band CPW-feed microstrip patch antenna for wireless communication. In proposed design, we simulated and analyzed for quad band antenna with three rectangular slot on patch and one rectangular shape slot on ground plane of antenna. We simulated for s-parameter, VSWR, radiation pattern using different dimension of slot. The impedance bandwidth can be tuned by changing the ground plane geometry parameters (length and/or its width). The overall size of the antenna is 25mm × 21mm × 0.8mm including finite ground feeding mechanism. The proposed antenna operates in four narrow bands which are (3.35 -3.5 GHz), (4.3-4.6 GHz), (6.8-7.1GHz) and (10.2-10.5GHz). Stable Omni-directional radiation patterns in the desired frequency band have been obtained.

Keywords:— *Multiband antenna, CPW-fed, microstrip antenna*

I. INTRODUCTION

With rapid development of micro strip antenna it has been found that, Study of Microstrip antenna with symmetrical Feed Line technique, Patch Antenna experimentally increase the Return Loss up to -33dB at frequency range 2.4 GHz to 2.5GHz and VSWR is less than 1.5 by using RT DUROID 5880[1]. With further study and optimization of dual band microstrip antenna [2] it has been found that the return loss for dual band Frequency at 2.4GHz is -43dB and at 3GHz is -27dB and acceptable VSWR. To get compact size and maintain performance of antenna for multiple bands that is dual band, triple band antenna etc., various shapes of antenna was integrated [3]. It was presented in [4], introducing slot into patch that is L-Shape, experimentally increase bandwidth up to 13%. To enhance bandwidth further various shapes like L-shape, U-shape etc., slot was introduced and bandwidth up to 42% was increased [5,6]. In [7] and [8] the author's proposed bandwidth enhancement techniques that are by using photonic band gap structure and wideband stacked microstrip antennas respectively. By introducing stacked microstrip antenna bandwidth and gain was enhanced. While Designing of symmetrical microstrip antenna, it has been found that microstrip antenna has narrow Bandwidth [8,9], Asymmetrical position of patch antenna on ground affect the performance of antenna that is to enhance bandwidth it was also found that asymmetrical position of slot on patch affects performance of antenna[9] that is asymmetrical L-shape, U-shape position of slot on patch affects the performance. In [9] designed asymmetrical slot of L-shaped on patch antenna for UWB application with acceptable return loss that is -10dB and peak gain 2.2 to 6.1 dBi for operating bandwidth 3.01-11.30 GHz frequencies.

In this paper we proposed L-shaped microstrip antenna using line feed with two L-shaped slots printed on dielectric substrate (pl. ref. Figure 1). The proposed antenna offers multi-bands (four) operations. Design and optimization procedure of the proposed antenna is presented in Section 2. Section 3 presents the validation of the simulated prototype and discussions on the measured results are also presented there. Finally, conclusions of this study are presented in Section 4.This antenna presents an extension to Analysis of a Miniaturized Multiresonant Wideband Slotted Microstrip Antenna With Modified Ground Plane [10].

II. PROPOSED WORK

The results of proposed narrow quad band microstrip patch antenna verified in HFSS Simulator with optimization. The resulting antenna structure has the following dimension; the patch shape length Wp = 16 mm, and its width Lp =12 mm, thse size of slot on patch is 2mm × 2mm. The size of the ground plane has been found to be of Lg =21 mm and Wg = 25 mm. The height of substrate is h= 0.8 mm and dielectric constant ε_r = 4.4. A line CPW-feed is attached to the microstrip and has a length 5 and width 1.8mm. The initial antenna simulation setup is shown in Figure 1. Actual patch shape is shown in figure 2, it consists of two L-shape notch on patch, one rectangular slot and one rectangular slot on ground plane.

The key design parameters used for the optimization are dimension of rectangular slot placed at center of patch, L-shape (length and width of L-slot), gap between to L-shape patch and dimension of rectangular slot on ground plane. For optimization we prefer d, W_t, D_p, since these dimensions provide optimum result for narrow band design. The detailed analysis of these parameters is investigated in the following paragraphs of this section. As showed in figure 3, ground plane of the geometry is varied to see its effect on the performance of antenna. For this, upper and lower ground plane is changed. The ground plane is located on the reverse side of the substrate in the shape of a rectangle, covering the entire back. Return loss characteristics of this study are presented in figure 4.

From figure 3, it may be noted that ground plane dimensions are finalized to get quad bands. Further we changed width of L-shape (Wt), length of L-shape (d) and gap. Figures (4), (5) and (6) show return loss characteristics plots of this study. From these figures it may be noted that the quad bands can be obtained for W_g= 24mm, L_g=22mm, and L_{g2}=12mm.

Table 1: The Finalized Dimensions Obtained from these Parametric Studies.

Parame-ter	L_p	W_p	d	Wt	Ws	L_t	W_g	L_g	D_p
Unit (mm)	16	12	8	1.5	4	6	25	21	9

To study the effect of L-shape dimensions on the antenna performance, its dimension values i.e., d, W_t and D_p are varied. Initially, length of L-shape on patch varied from 6mm to 8.5mm in steps of 0.5mm keeping dimension of ground plane constant and return loss is presented in figure 4. The effects of variation of this study for different values of W_t and D_p in steps of 0.1mm and 1 mm respectively are presented in figure 5 and figure 6, it may be noted that the quad bands with return loss less than -15dB are (3.3-3.6GHz), (4.2-4.5GHz), (6.9-7.2GHz), and (10.1-10.4GHz).

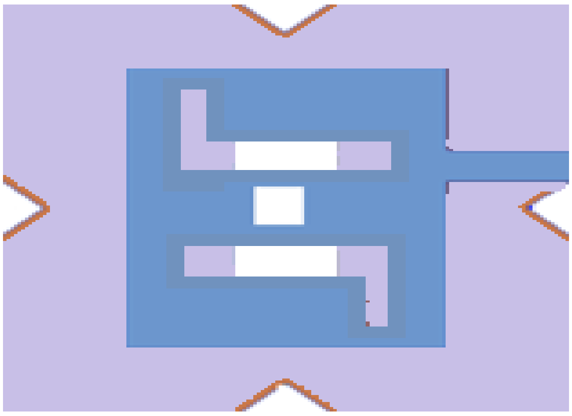

Figure 1. Proposed Antenna Simulation Setup

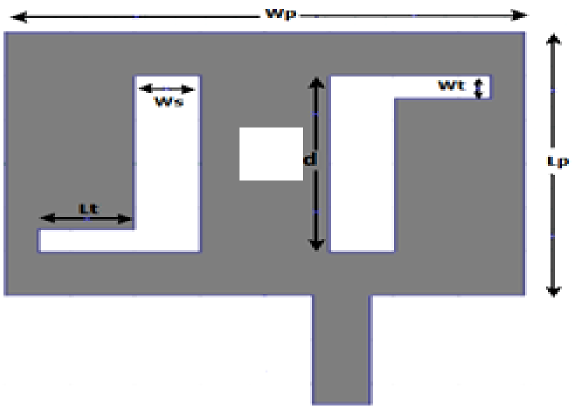

Figure 2: Proposed antenna design (Patch)

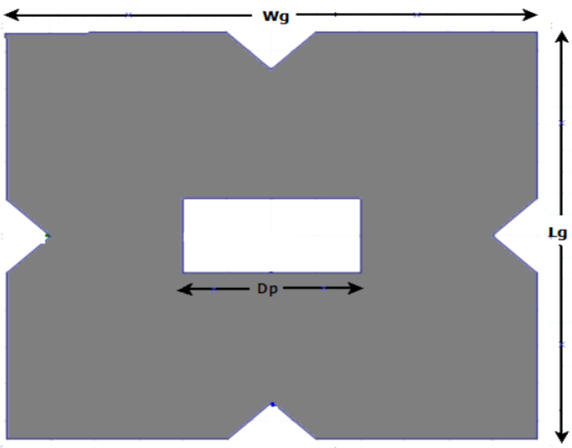

Figure 3: Proposed Antenna Design (Ground)

From figure 4 and figure 5, it is observed that, we get minimum return loss that is -25dB, -15dB,-20dB and -45dB at 3.3 GHz, 4.1GHz, 7.00GHz and 10.2 GHz respectively.

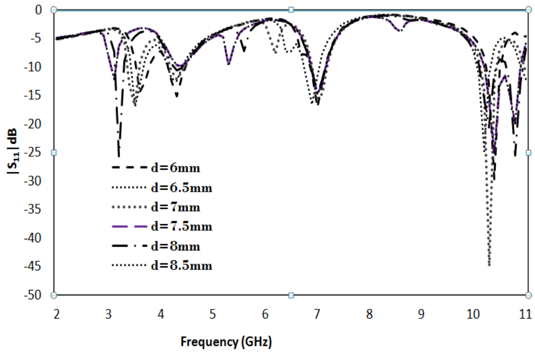

Figure 4: Return loss of antenna for variation in L-slot on Patch (variation in "d")

Results of the variation of the size of the ground plane, as Figure 6 implies that the quad band response increases for ground plane reduction by introducing slot into it.

However, quad-band responses are obtained with increased or decreased higher resonating bands. The effect of the width of ground has been demonstrated in Figure 5, and Figure 6.

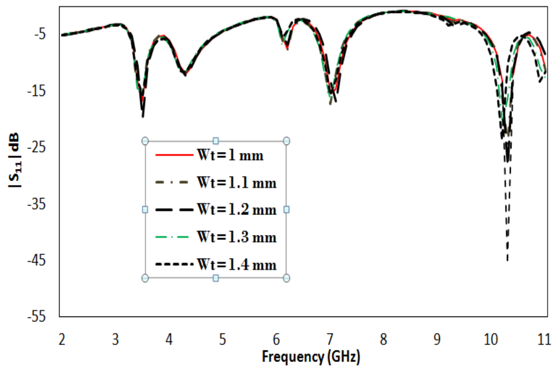

Figure 5: Return loss of antenna for variation in L-slot on Patch (Variation in "W_t")

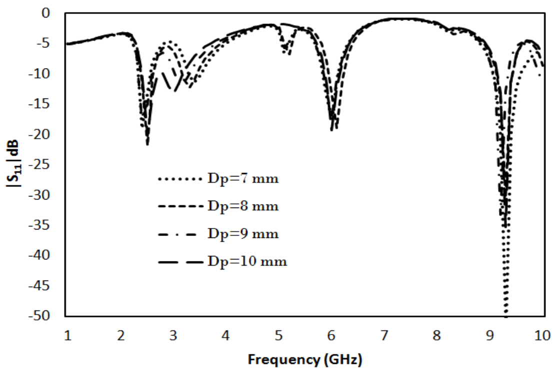

Figure 6: Return Loss of Antenna for Variation of Slot on Ground Plane

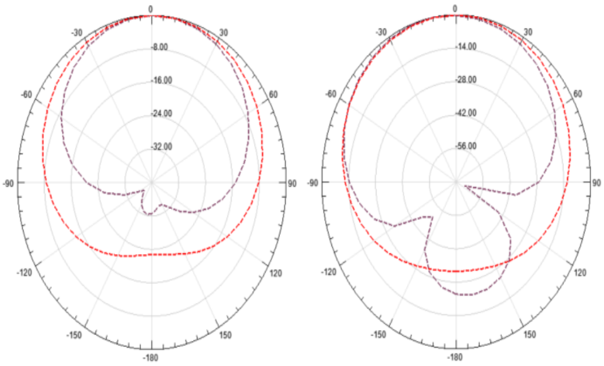

Figure 7: E- and H-Plane Patterns at 3.4 GHz

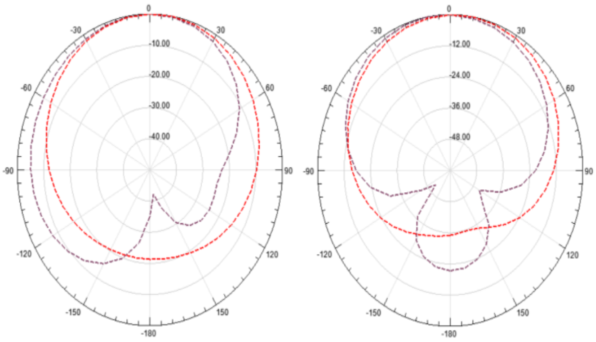

Figure 8: E- and H-Plane Patterns at 4.2 GHz

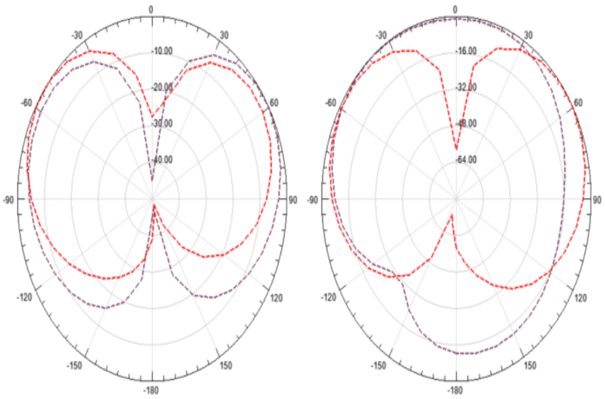

Figure 9: E- and H-Plane Patterns at 6.9 GHz

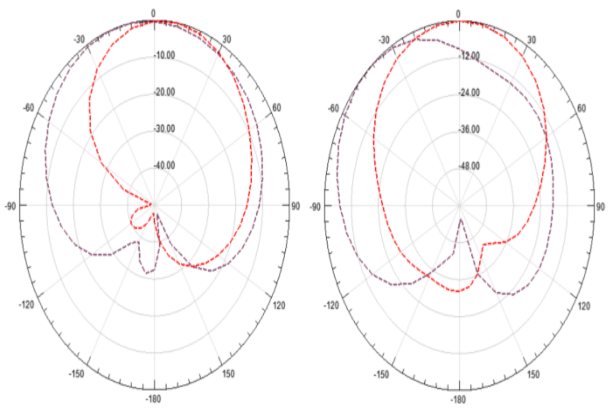

Figure 10: E- and H-plane patterns at 10.1 GHz

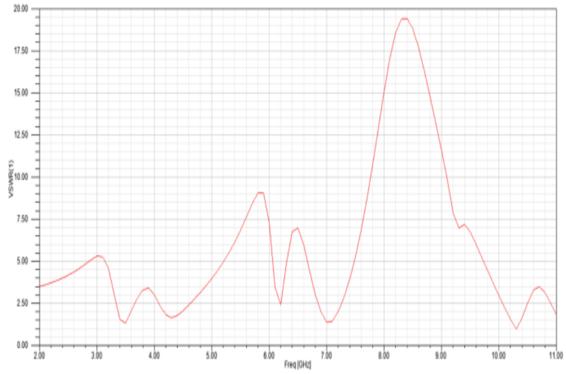

Figure 11: VSWR

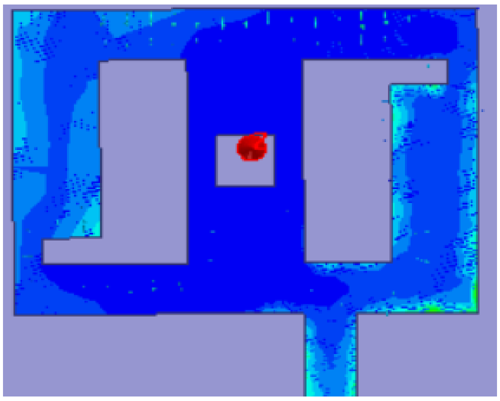

Figure 12: Current Distribution

Figure 7 to10 depicts the radiation pattern for quad band that is at 3.3GHz, 4.3GHz, 7.00GHz and 10.0GHz frequency since return loss at this frequency is -23dB, -14dB, -21dB and -39dB respectively. Figure (11) represents VSWR for all band, VSWR is less than 2 for all band that is good matching between feed line patch. Figure 12 presents current distribution.

III. CONCLUSION

The antenna has been modeled and its performance has been analyzed using a HFSS simulator. The proposed antenna has been found to possess a miniaturized size and acceptable return loss at respective band with perfect matching.

It has been shown that, with correct selection of slot dimensions on patch and shape of ground plane, a quad band frequency response can be achieved. With this antenna, we get quad band that is (3.35-

3.5 GHz), (4.3-4.6 GHz), (6.8-7.1GHz) and (10.2-10.5GHz). The simulated results of HFSS at 3.3 GHz is Return loss = -23dB, at 4.3GHz Return loss = -14 dB, at 7.00GHz Return loss = -21dB and at 10.1GHz Return loss = -39dB. VSWR at 3.3 GHz is 1.2.

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