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High Frequency Tri-band Patch Antenna with Enhanced Bandwidth

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Abstract

We demonstrated and presented triple band line fed microstrip patch antenna for wireless communication application. In proposed design, we introduced F-shape patch and ground plane of antenna, to enhance the bandwidth of mictrostrip antenna. Adjusting the dimension of ground plane and patch, its enhanced bandwidth at primary and secondary resonance mode can increased sufficiently to achieve desired bandwidth of proposed antenna. We demonstrated many antenna structures to study of these parameters on the resulting tri band response. In this paper, we designed tripple-band microstrip rectangle antenna with slot antenna using line-feed technique, it support the three wireless communication bands that is (12.9-14.3 GHz), (18.2-19.8 GHz) and (20.8-23.8 GHz).

Key Words: Trippleband Microstrip antenna, bandwidth enhancement, Co-axial feed technique.

1. INTRODUCTION

With development of wireless communication and microstrip antenna it has been found that, Microstrip antenna analysis with different feed technique like co-axial, line-feed technique etc, is good candidate t improve antenna performance. Microstrip patch Antenna experimentally optimize antenna parameters and decreases the Return Loss up to -35dB for the frequency range to operate for Bluetooth antenna in frequency range 2.4 GHz to 2.5GHz and VSWR is less than 1.5 by using RT DUROID 5880[1]. In further study of 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 band 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 is by using photonic band gap structure and wideband stacked microstrip antennas respectively. By introducing stacked microstrip antenna band width and gain was enhanced. While Designing of symmetrical microstrip antenna, it has been found that microstrip antenna has narrow Bandwidth [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[10] that is asymmetrical L-shape, U-shape position of slot on patch affects the performance. In [10] 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 simulated and presented our design by using HFSS.13 simulator. In this paper a line feed patch with two rectangle slot microstrip antenna with two antisymmetrical notch (Figure 1) is designed and simulated for the frequency range of 1-5 GHz. This antenna presents an extension to Miniaturization of Differentially-Driven Microstrip Planar Inverted F Antenna [11]. The proposed antenna has a gain of 1.7 dBi.

2. PROPOSED DESIGN

The results of proposed triple band microstrip patch antenna verified in HFSS Simulator with optimization. Actual patch shape is shown in figure 1, it consists of symmetrical F-shape structure on both side of dielectric substrate. On patch side and ground side parasitic symmetrical rectangle are introduced (as shown in figure 1 & 2). The resulting antenna structure has the following parameters; the dielectric substrate has length L = 18.4 mm, and its width W =13 mm, dielectric constant and height of substrate are εr = 4.4 (FR-4) and h= 1.0mm respectively.

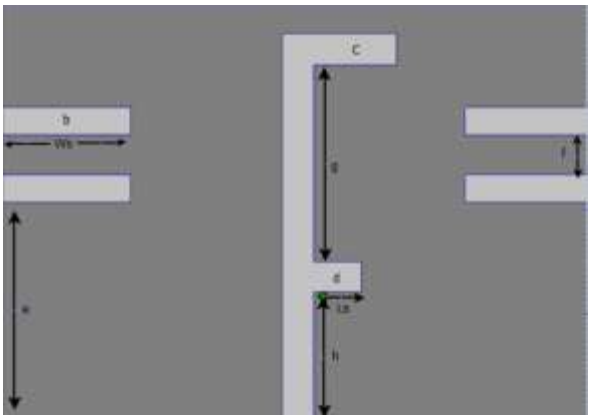

Figure 1: Proposed antenna design (Patch)

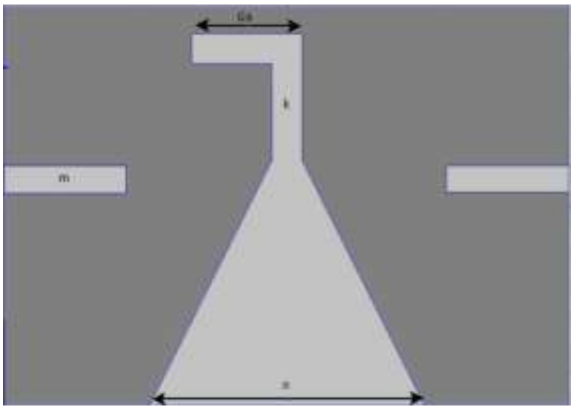

Figure 2: Proposed antenna design (Ground)

Initially, we will conduct a simulation study on the structure of Figure 1 and 2, the simulation parameters are presented in table 1, designed antenna for dual band antenna that is (13.5-13.9 GHz), (18.5-20.5 GHz).

Table 1. Simulation parameters

Parameter	Size in mm
b (Rectangle)	4.0 x 1.0
c (Rectangle)	3.5 x 1.0
d (Rectangle)	1.5 x 1.0
e (gap)	6.8
f (gap)	1.5
g (gap)	6.1
h (gap)	4.0
k(Rectangle)	3.0 x 1.0
m(Rectangle)	4.0 x 1.0
n (side of triangle)	9.0

Further we simulated to get third band, we introduced two rectangular slot (slot b in figure 1) on patch, we simulated for different dimension of rectangular slot on patch to get optimum result, dimension of rectangular changes from 1.0x3.9mm to 1.0x4.3mm and return loss is presented in figure 3. Further we changed the dimension of slot on ground plane (slot Gs in figure 2) from 3.4x1.0 mm to 3.8x1.0 mm, return loss is presented in figure 4. From return loss we observed that antenna is capble to operate for as tri band with return loss less than -15dB. Figure 3 and 4 presents triband response (13.5-14.1 GHz), (18.5-21 GHz) and (23.0-24.02 GHz) with return loss -15dB, 40dB and -12dB respectively at resonance frequency. For same triband frequency response to optimize antenna structure and antenna dimension we simulate antenna with dimension of F-shape patch. F-shape slot (slot d in figure 1) is varied from 1.4x1.0mm to 1.8x1.0mm is simulated and optimized results are presented in figure 5, return loss for tri-band frequency ((13.5-14.1 GHz), (18.5-21 GHz) and (23.0-24.02 GHz) is -15 dB, -25dB and -40dB respectively. Optimized results shows that antenna is capable to operate for tri-band frequency.

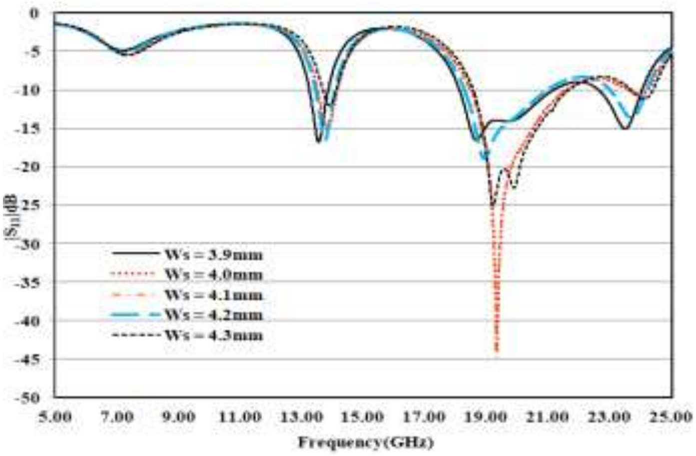

Figure 3: Return loss of antenna for variation in slot

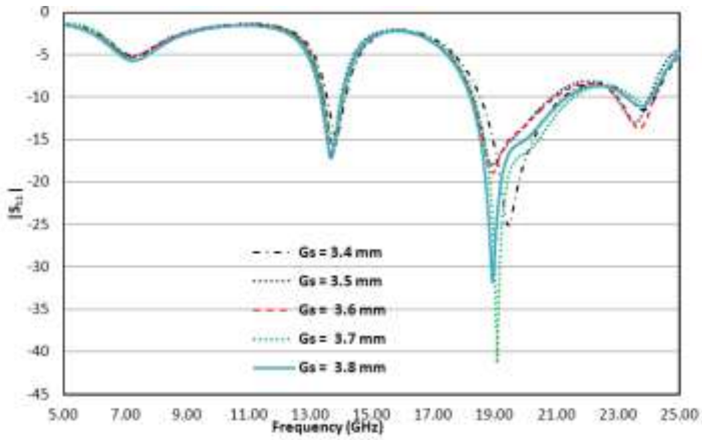

Figure 4: Return loss of antenna for variation in slot

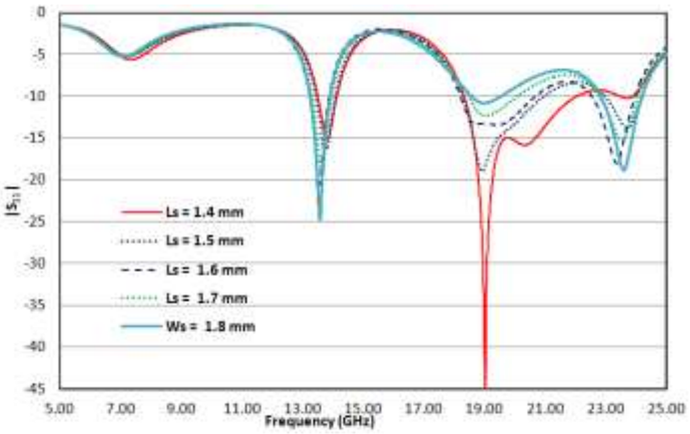

Figure 5: Return loss of antenna for variation in ground plane

From Figure 6, it is observed that tri band response can be enhanced further for first and third band of antenna we demonstrated to enhance performance further by varying dimension of triangular patch on ground plane, It is observed that clear impact on return loss of first and third band that is return loss is reduced further and band is enhanced. We are able to achieve tri band response with more than 1GHz bandwidth, for frequency band 12.9-14.3 GHz, 18.2-19.8 GHz and 20.8-23.8 GHz.

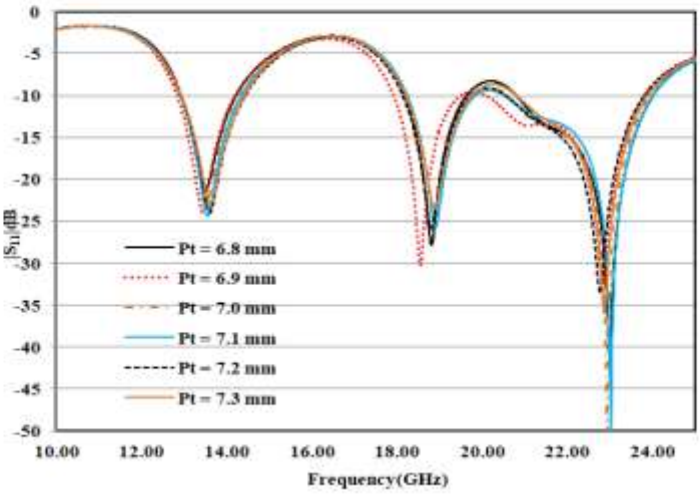

Figure 6: Return loss of antenna for variation triangular plane (Ground)

It is also observed that tri band response is stable for different values of triangular plane.

For larger values of the width of ground, the antenna offers a one-band resonant behavior, and the tri-band resonance occurs as the width is made smaller and approaches that of the reference antenna. E-plane and H-plane radiation Pattern of proposed antenna is presented in Figures 7-9 at 13.75 GHz, 19.0 GHz, and 23.75 GHz respectively.

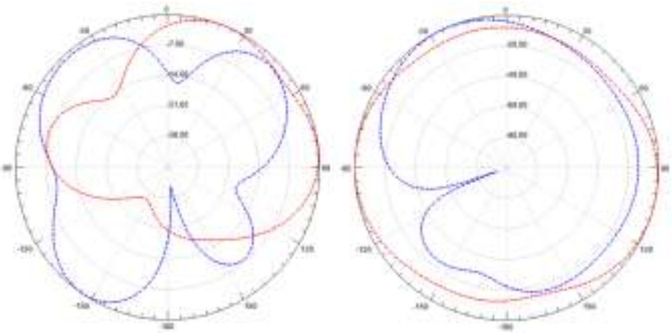

Figure 7: E-Field and H-Field Radiation pattern at 13.75 GHz (Red: θ=0°, Green: Φ=90°)

From parametric s study of antenna of antenna it observed that, designed antenna is good candidate for multiband application. Table 2, presents overall antenna response and operating frequency. Figure 9, present VSWR for triband response

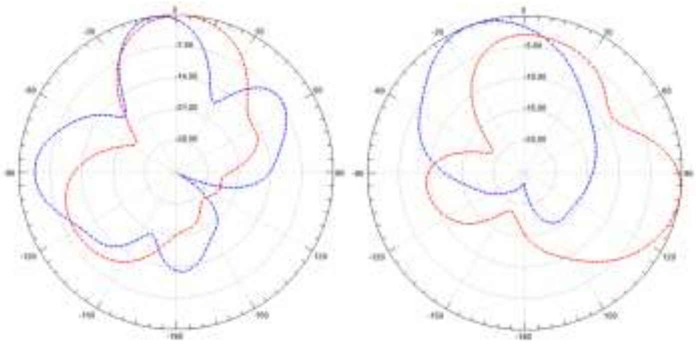

Figure 8: E-Field and H-Field Radiation pattern at 19.0GHz (Red: θ=0°, Green: Φ=90°)

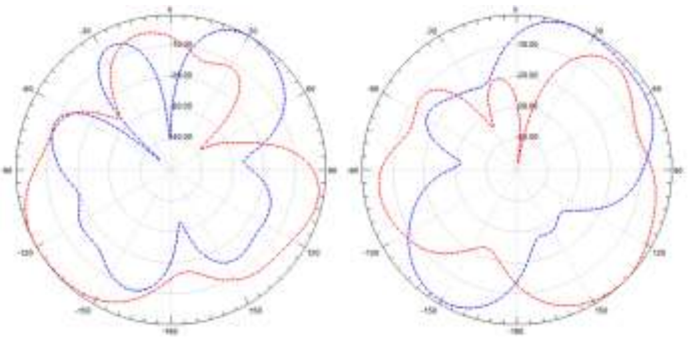

Figure 9: E-Field and H-Field Radiation pattern at 13.75GHz (Red: θ=0°, Green: Φ=90°)

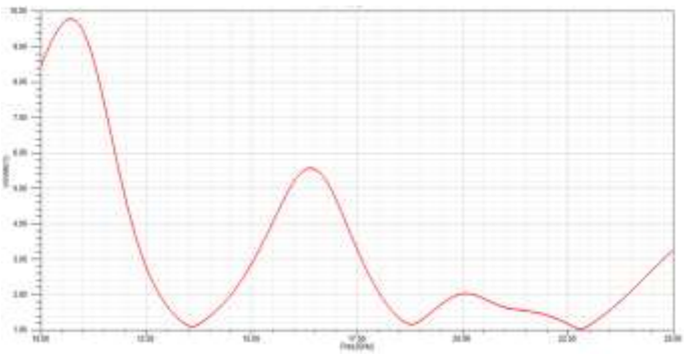

Figure 10: VSWR

Table 1: Simulation Result

Frequency	Bandwidth	Return loss	VSWR
12.9-14.3 GHz	1.4 GHz	-25	1.1
18.2-19.8 GHz	1.6 GHz	-30	1.1
20.8-23.8 GHz	3.0 GHz	-50	1.0

3. CONCLUSIONS

The designed antenna is good solutions for tri band applications as its ooffer tri band frequency response. The design optimization of a F-shaped patch with finite ground plane antenna has been presented. It has been shown that, with correct selection of slot dimensions on patch and shape of ground plane, a tri band frequency response can be achieved. With this antenna, we obtained tri bands at 12.9-

14.3 GHz, 18.2-19.8 GHz and 20.8-23.8 GHz. The proposed antenna was been analyzed using a HFSS simulator.

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