Miniaturized Quad-Band Line fed Narrow Band Antenna

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Abstract - *We demonstrated and presented miniaturized narrow bandwidth quad band line fed microstrip patch antenna for multiband wireless communication application. In proposed design, we introduced patch with anti-symmetrical triangular slot and rectangular slot to enhance the performance of mictrostrip antenna. Adjusting the dimension of triangular shaped slot, its enhanced narrow band performance at primary and secondary resonance mode can increased sufficiently to achieve desired bandwidth of proposed antenna. We simulated many antenna structures to study of these parameters on the resulting quad band response. In this paper, we enhanced performance of quad-band microstrip rectangle antenna with slot antenna using line-feed technique, it support the three wireless communication bands that is (2.1-2.3 GHz), (3.83-4.15GHz), (5.57-5.9 GHz) and (7.36-7.62GHz).*

Key Words: Quad band Microstrip antenna, bandwidth enhancement, line 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 1.8 dBi.

2. PROPOSED DESIGN

The results of proposed quad band microstrip patch antenna verified in HFSS Simulator with optimization. Actual patch shape is shown in figure 1, it consists of anti-symmetrical triangular structure on patch side of dielectric substrate. On ground side parasitic rectangular shaped of dimension 80x60 mm is placed. The resulting antenna structure has the following parameters; the dielectric substrate has length L = 80 mm, and its width W =60 mm, dielectric constant and height of substrate are εr = 4.4 (FR-4) and h= 1.6mm respectively.

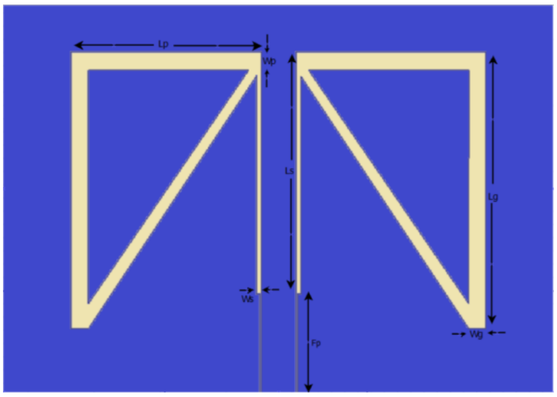

Figure 1(a). Proposed antenna design (Patch)

Figure 1(b). Proposed antenna design (Ground)

Initially, we will conduct a simulation study on the structure of Figure 1, the simulation parameters are presented in table 1, designed antenna for dual band antenna that is (3.83-4.15GHz) and (5.57-5.9 GHz).

Table 1. Simulation parameters

Parameter	Size in mm
Lp	25
Wp	2.5
Ls	32.5
Ws	0.4
Lg	40
Wg	2.5
Fp	15
Patch	80x60
Ground	80x60

Further we simulated to get third band, we introduced symmetrical triangular slot on path as shown in figure 1. Antisymmetrical position of antenna created even mode in antenna structure which result in triband antenna (3.83-4.15GHz), (5.57-5.9 GHz) and (7.36-7.62GHz). To enhance performance of tri band antenna, rectangular slot like side, bottom and central rectangle varied with different dimension. We changed side rectangle width from 2.5 mm to 3.0 mm, return loss is shown is figure 2, using this simulation dimension we are able to get lower band at frequency 2.1-2.3GHz so quad band response is (2.1-2.3 GHz), (3.83-4.15GHz), (5.57-5.9 GHz) and (7.36-7.62GHz). For quad band (2.1-2.3 GHz), (3.83-4.15GHz), (5.57-5.9 GHz) and (7.36-7.62GHz) return loss is -15dB, -30dB, -40dB and -30dB respectively. Return los for variation of dimension of center and bottom rectangle is presented in figure 3 and figure 4.

Graph 3 and 4 presents antenna performs at resonance frequency.

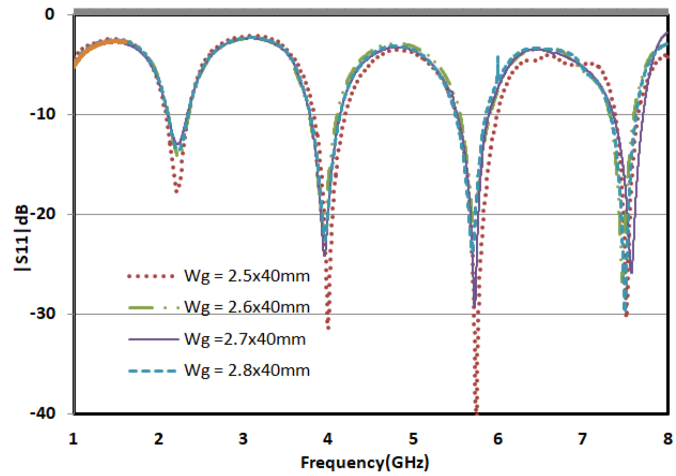

Fig 2: Return loss of antenna for variation in slot (Left slot of triangle)

Return loss presented in figure 2 and 3 presents, small change in dimension will affect antenna performance. Also small change in resonance frequency affects response of antenna suddenly, that is antenna is frequency sensitive. From graph, higher band performance is good, antenna resonate good for higher frequency than lower frequency.

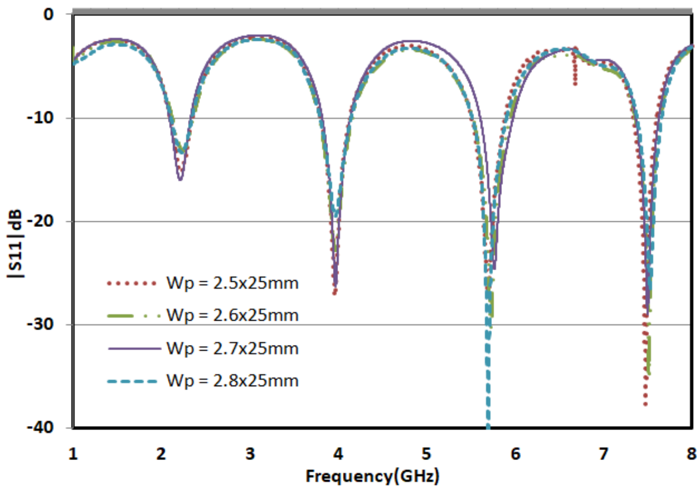

Fig 3: Return loss of antenna for variation in slot (Bottom slot of triangle)

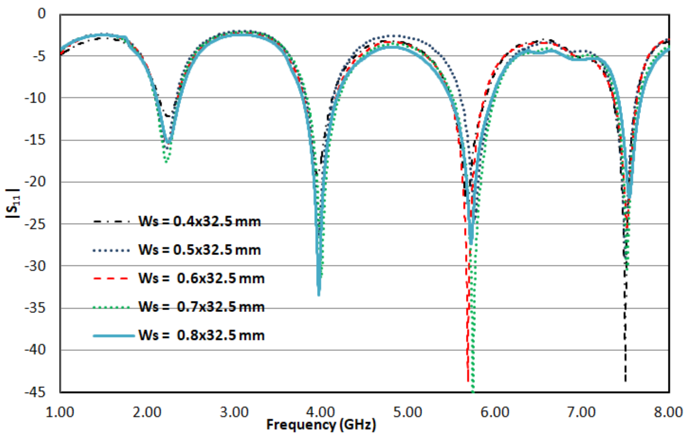

Fig 4: Return loss of antenna for variation in ground plane (Center slot of triangle)

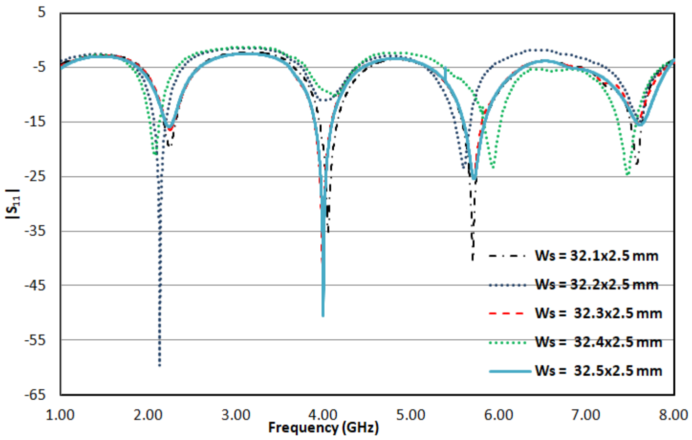

Fig 5: Return loss of antenna for variation in ground plane (Ground slot)

For larger values of the width of ground, the antenna offers a one-band resonant behavior, and the quad-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 6-9 at 2.2 GHz, 4.0GHz, 5.75 GHz, and 7.51 GHz respectively.

We further enhanced the performance of microstrip antenna, by reducing antenna size and introducing slot. In this work we are able to reduce antenna size by 10mm X 5mm, as shown in table 2, while performance also enhanced as presented in figure 5. As size of antenna is reduced, to enhance the performance we introduced two rectangular slot of 32.3mm X 2.5mm on ground plane. We simulated for different values of slot, return loss is presented in figure 5.

Table 2. Reduced simulation parameters

Parameter	Size in mm
Lp	25
Wp	2.5
Ls	32.5
Ws	0.4
Lg	40
Wg	2.5
Fp	15
Patch	70x55
Ground	70x55

For enhanced performance of quad band (2.1-2.3 GHz), (3.83-4.15GHz), (5.57-5.9 GHz) and (7.36-7.62GHz) return loss is -55dB, -45dB, -35dB and -25dB respectively. This enhanced performance of antenna is good practical solution

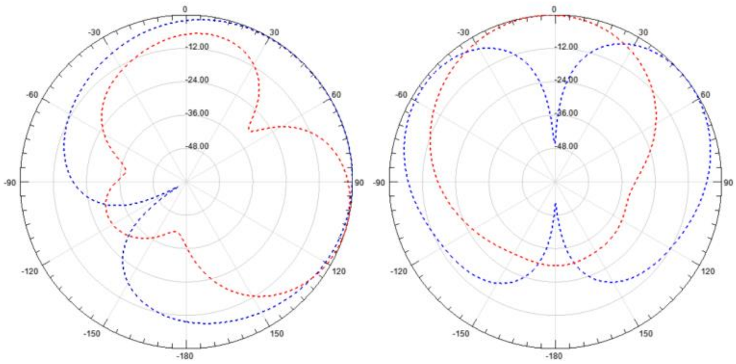

Fig. 6 E-Field and H-Field Radiation pattern at 2.2 GHz (Red: $\theta=0^{o}$, Green:$\Phi=90^{o}$)

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 parameters. Figure 10, present VSWR for quadband response

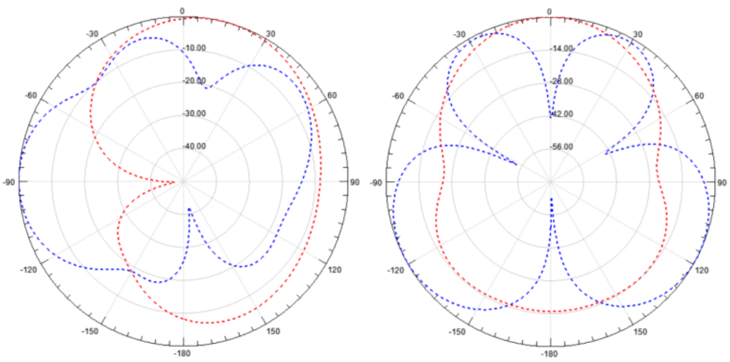

Fig. 7 E-Field and H-Field Radiation pattern at 4.0 GHz (Red: θ=0°, Green: Φ=90°)

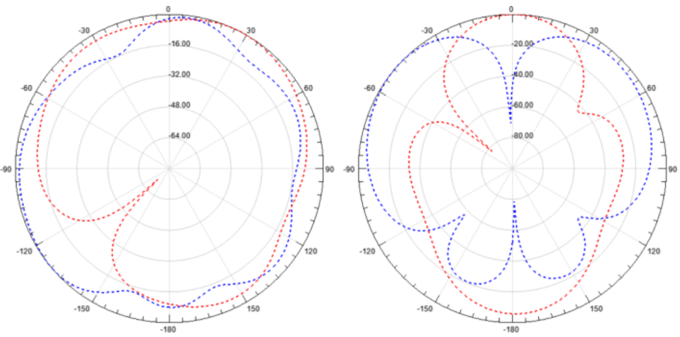

Fig. 8 E-Field and H-Field Radiation pattern at 5.75 GHz (Red: θ=0°, Green: Φ=90°)

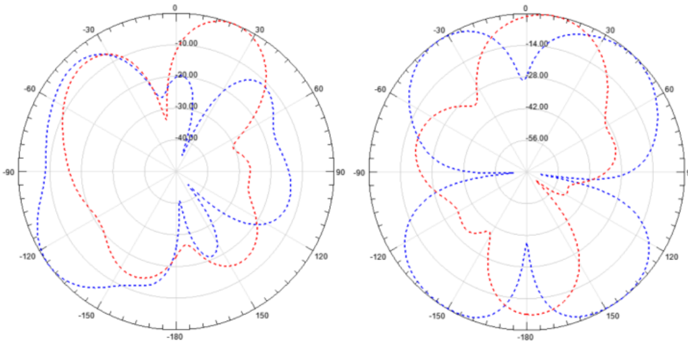

Fig. 9 E-Field and H-Field Radiation pattern at 7.51 GHz (Red: θ=0°, Green: Φ=90°)

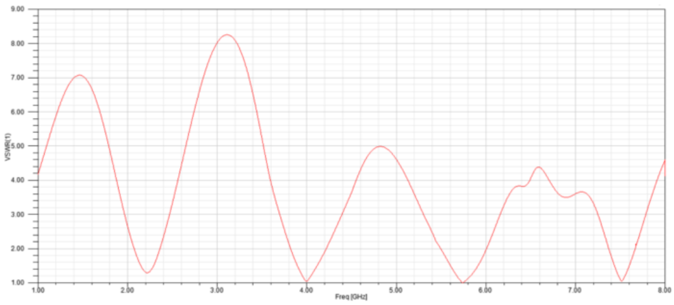

Fig. 10 VSWR

4. CONCLUSIONS

The design and optimization of a triangular 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 quad band frequency response can be achieved. With this antenna, we obtained quad bands at (2.1-2.3 GHz), (3.83-4.15GHz), (5.57-5.9 GHz) and (7.36-7.62GHz). The proposed antenna was been analyzed using a HFSS simulator. Graph presented for Return loss, VSWR and Radiation presents antenna is good candidate to operate for mentioned dimension also good solution for quad band application.

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