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Patch Antenna Loaded With Meander Line and Partially Defected Ground for Satellite Communication

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***Abstract*- This paper presents the design of proposed antenna for X-band and Wi-Max (Worldwide Interoperability for Microwave Access, 3.2−3.8 GHz) applications. In proposed antenna slots created in ground plane and top patch provides wide bandwidth (4.6GHz) in X-band. This design approach is meant for satellite communication, amateur radio, military communication and middle band of Wi-Max applications.**

***Keywords*- Satellite Communication, Wi-Max Defected ground structure, circular polarized antenna.**

I. Introduction

Presently microstrip patch antennas became the most famous due to their applications and merits like less fabrication cost, light weight, compact shape and covers wide range of frequencies. Moreover it has some drawbacks such as narrow bandwidth, low gain and low efficiency etc. Many researchers preformed to overcome these demerits. In this paper microstrip fed dual band antenna is designed by loaded with meander line in the radiating patch and introducing partially defected ground (PDGS) in the ground plane to enhance the bandwidth. The proposed patch antenna is operating in middle band of Wi-max frequency range (3.2-3.8GHz) and X-band (8-12GHz). In this paper, a good bandwidth is achieved for X-band using partial defect in ground. Moreover radiation characteristics, realised gain, axial ratio and VSWR are obtained by using HFSS with satisfying result values. To design an efficient microstrip patch antenna (MPAs) for satellite communication required to design at specific range of frequency as C band, X, Ka, Ku and S-band with suitable feeding techniques and dielectric substrate[6]. Circular polarisation is often needed for satellite communication application for reduction of any orientation related problem of the receiving based station antennas. In our design AR < 3 is achieved, which is necessary condition for circular polarization.

II. Antenna Geometry and Design

The geometry of the proposed antenna with microstrip feed line is shown in the figure 1. In this paper the proposed antenna is printed on an FR-4 (dielectric constant is 4.4 and loss tangent is 0.02) substrate with size $22 \times 28.8 \times 1.6$ mm^3.To achieve 50 Ω characteristic impedance, the width of the microstrip line is 1.4mm.

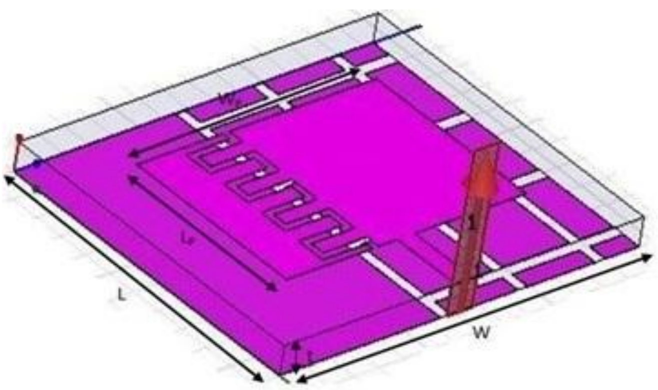


Fig 1: Schematic diagram of microwave-fed meander line loaded MPA placed over PDGS

Length and width of the ground for the proposed microstrip patch antenna is calculated as:

$$L = Lp + 6 \quad (1)$$

$$W = Wp + 6 \quad (2)$$

In this paper, meander line is etched on the radiating patch and the crossed strip line are etched on the ground plane of the Microstrip patch antenna creating partially defect in ground plane fig 2.

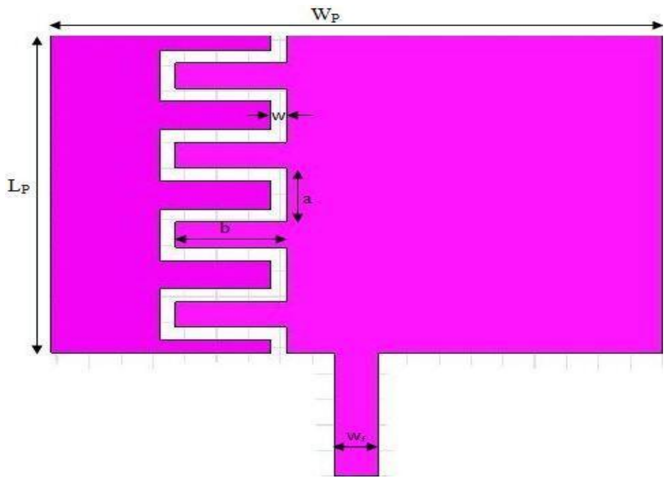


Fig 2: (a) design parameters of meander line: L_P=19.2mm, W_p=12.4mm, w=0.5mm, a=3mm, b=4mm

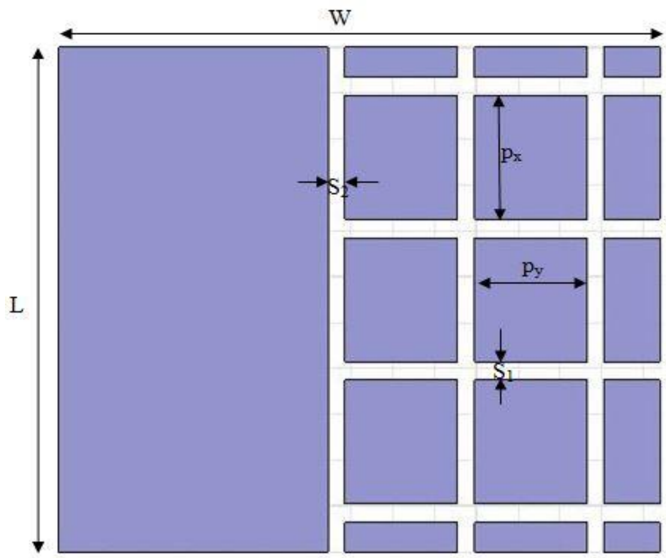
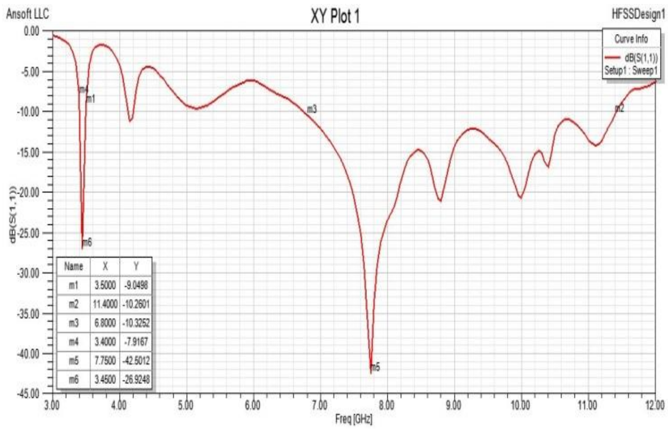


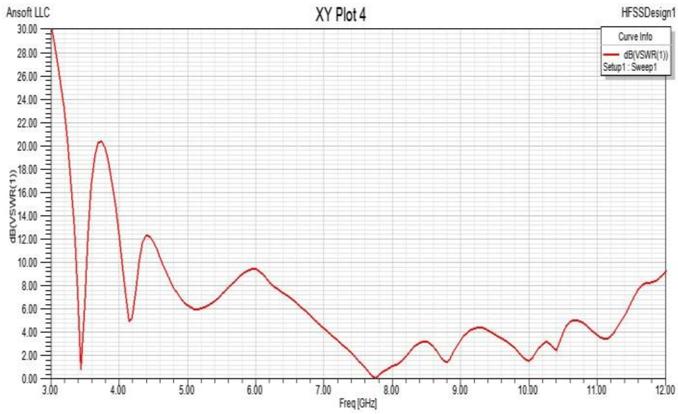
Fig 2: (b) design parameters of PDGS: S_1=0.8mm, S_2=0.7mm, p_x=4.6mm, p_y=4.2mm

III. SIMULATION AND RESULT

The all results of proposed antenna were simulated by HFSS (high frequency simulator structure) version 16. The simulated return loss and VSWR versus frequency of the proposed antenna is depicted in fig 3. It is observed from the result that microstrip patch antenna resonate at the 3.37-3.49GHz which encompasses the middle range of WiMAX (3.2-3.8GHz) and 6.78-11.3GHz which covers the entire X band (Uplink 7.9-8.4GHz and Downlink 7.25-7.75GHz) as well as Amateur Radio band (10.450-10.50GHz) and Military communication band (8.5-10.5GHz), this shows that MPA is working in two bands.



(a)



(b)

Fig 3 (a) return loss versus frequency (b) VSWR versus frequency

The radiation characteristics of proposed MPA such as realised gain, axial ratio, radiation pattern, efficiency and directivity have also been measured in a far field range. The realised gain, shown in fig 4(a) of the proposed antenna at 7.5GHz is 2.03dB and at 8.05GHz is 2.61dB. For Amateur communication region (10.45-10.50GHz), it is 1 dB. The efficiency of the proposed antenna is approximately one which is shown in fig 4(b). Fig 4 (c) shows the axial ratio of the MPA with respect to the frequency. From graph it is observed that at uplink and downlink frequencies of the proposed antenna is optimized for best CP radiation (AR < 3).

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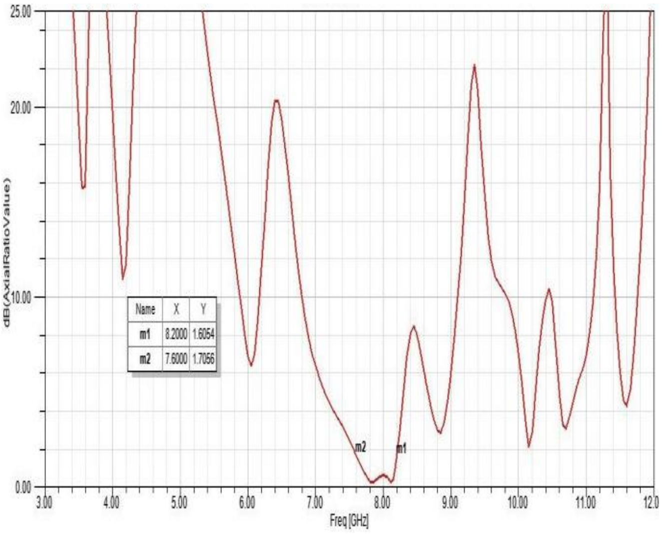


Fig 4(a): Realised Gain Vs frequency

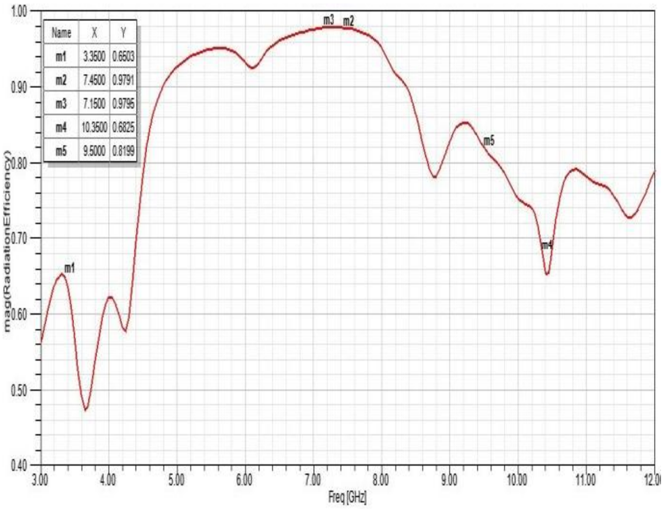


Fig 4(b): Efficiency of proposed MPA

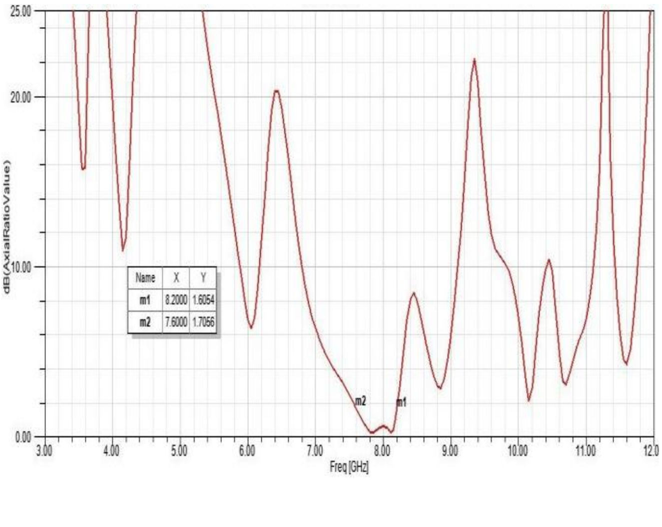
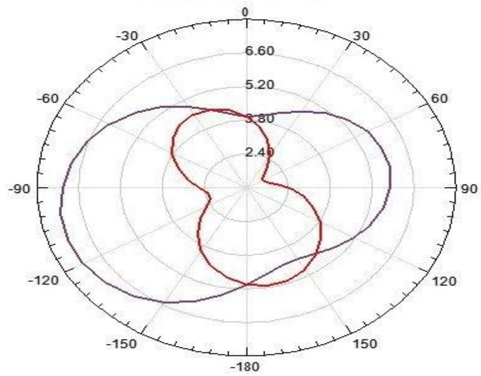
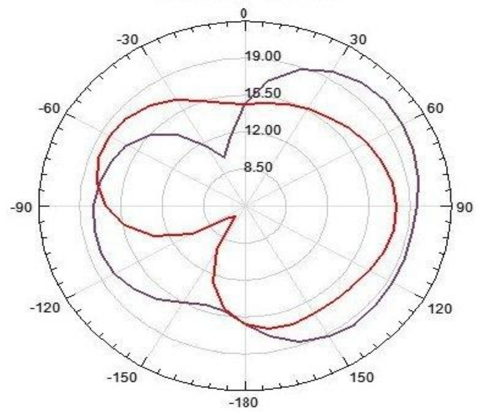


Fig 4(c): Axial Ratio of proposed MPA

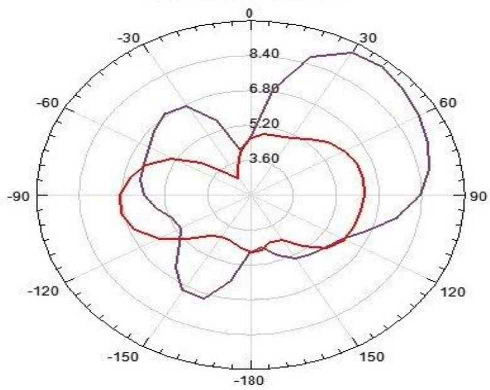
The radiation pattern at (a) 3.4GHz (b) 7.5GHz (c) 10.5GHz have plotted in fig 5. And fig 6 shows the 3-D radiation pattern for the above resonant frequencies.



(a)



(b)



(c)

Fig 5: Radiation Pattern of proposed MPA at

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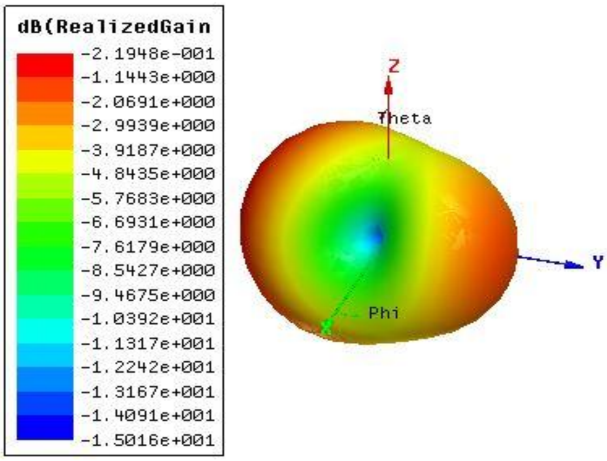
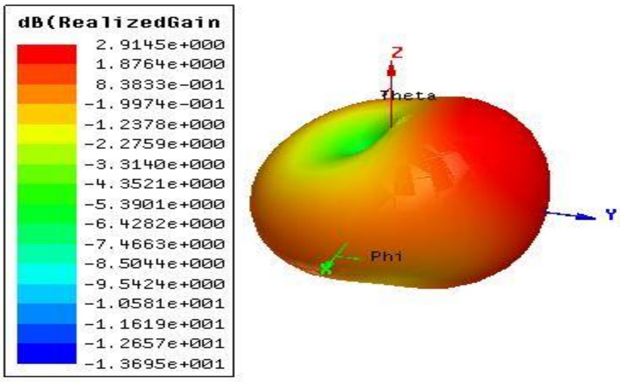
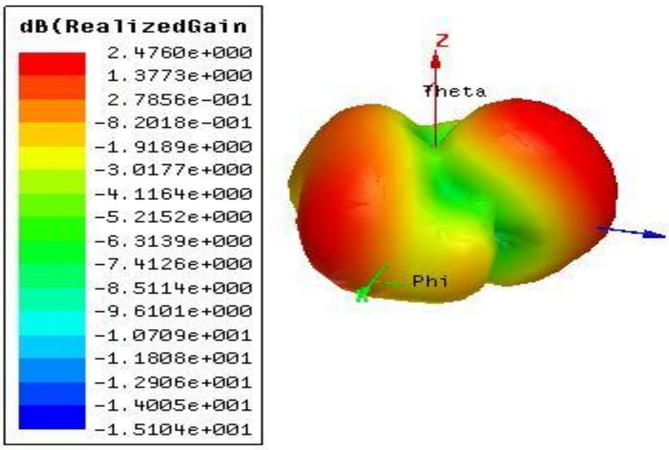
(a) 3.4GHz (b) 7.5GHz (c) 10.5GHz



(a)



(b)



(c)

Fig 6: 3-D polar plot of proposed MPA at

(a) 3.4GHz (b) 7.5GHz (c) 10.5GHz

IV. CONCLUSION

In this paper we designed a dual band microstrip patch antenna. By introducing crossed strip lines in ground plane and meander line at patch we improved the return loss (S_{11}) and VSWR with amazing bandwidth (4.6GHz) in comparison with reference antenna [2]. This antenna also works in middle range of Wi-Max applications. We also analyse the axial ratio, radiation pattern, gain and polar plot for all resonant frequencies. We observed from graph for uplink (7.9-8.4GHz) and downlink (7.25-7.75GHz) frequencies the average gain in 1.5dBi and the axial ratio is near to one that implies circular polarisation in this range (X-band).

V. REFERENCES

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