DESIGN OF MULTI SLOTTED AND MULTI FREQUENCY PATCH ANTENNA

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Abstract-Design of Low profile single feed dual band microstip antenna operated at Wi-Fi/Wi-Max system is presented. It is demonstrated that by cutting slots into radiating edges of microstip patch antenna, a dual frequency response is achieved. The antenna was studied by means of numerical simulation. The return losses at 2.45 GHz, 3.4 GHz are -21.5dB, -13.2 dB respectively. Its bandwidth of 35MHz extends from 2.435GHz to 2.47GHz at the lower band. Its radiation patterns are also studied.

Index: Microstip patch antenna, dual band antenna, IE3D simulator.

I. INTRODUCTION

In satellite and wireless mobile communication applications, microstrip antennas have attracted much interest due to their small size, light weight, low cost on mass production, low profile and easy integration with other components [1-2]. Simple patch antenna geometries of regular shape in general resonates only at a single resonance frequency and their bandwidth is also very poor (1 to 2%) [3-5]. With the recent advancements in mobile and wireless communication systems particularly for data communication, the demand for broad band, multi frequency and multi band patch antenna was realized. These requirements forced workers for modification in patch antenna geometries.

In applications where increased bandwidth in needed for operation of two or more separate sub-bands, a valid alternative to the broadening of total bandwidth is the use of dual or multi-frequency microstrip antennas [6-9]. Operation in two or more discrete bands with an arbitrary separation of bands is desired in many applications, such as Global Positioning system (GPS), Worldwide Interoperability for Microwave Access (Wi-MAX) and so on.

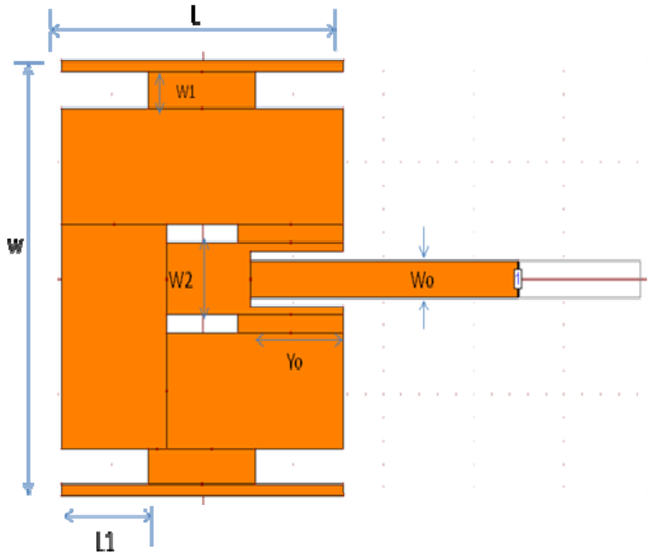

Figure 1: Patch configuration for inset-fed dual frequency patch antenna with L=39.6mm, W=47.9mm, W_0=4mm, Yo=13mm, W_1=4mm, W_2=10mm, L_1=14.2mm, ϵ_r=2.4 and h=1.58mm

II. DESIGN OF DUAL BAND MICROSTIP ANTENNA

The geometry of dual band rectangular microstip antenna is shown in fig 1. The dimensions W & L of rectangular patch are given in the caption of the figure. It is constructed on the substrate with dielectric constant (ϵ_r) of 2.4 and thickness (h) of $1/16^{th}$ of inch. The proposed structure is simulated using MoM based IE3D^{TM} version 14.0.

The design is for a resonant frequency of around 2.4 GHz. The first stage involves the creation of an additional $TM_{o\delta}$ resonant mode at a resonant frequency above that of the fundamental TM_{01} mode, with the same polarization sense. The second stage is to simultaneously bring the input impedance of both modes to 50Ω at resonances through the use of an inset feed.

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Stage 1: Creation of two resonant modes

The first point to note in the design process is the effect of slot separation on the patch design. With reference to the value of slot separation, simulation results have shown that placing the slots close to the radiating & non-radiating edges of patch increase the effect of slot length on resonant frequency. This gives greater freedom to tune the resonant frequency of the $TM_{o\delta}$ mode. Increasing the slot width produces an increase in input impedance of the TM_{01} mode.

As the slot width increases further, a stage is reached where the input impedance is too high for impedance matching. Regarding the effect of the slot length L_1 on creating an additional $TM_{o\delta}$ mode, the simulation results indicate that the slot length L_1 must take on a value of between 40% L and 55% L.

Stage 2: Achieving impedance matching at both frequencies

The first part of the impedance matching procedure is to produce equal value of input impedance at both resonant frequencies. The second part of impedance matching is achieved by varying W_1. The final stage in the design process involve the use of an inset feed is found that increasing the inset feed length L_1 and simultaneously reduced the impedance at both frequency to 50Ω.

III. RESULTS AND DISCUSSION

The simulated patch antenna gave a resonant frequency of 2.45 GHz. The simulated return loss curve is shown in fig 2. It is shown useful return loss peaks at 2.45GHz is - 21.5dB, 3.4GHz is -13.2dB. The lower-band bandwidth (< -10dB) is 35MHz, that extends from 2.435GHz to 2.47GHz. The radiation pattern at the both frequency in polar form is shown in figure 3 (a) & (b).

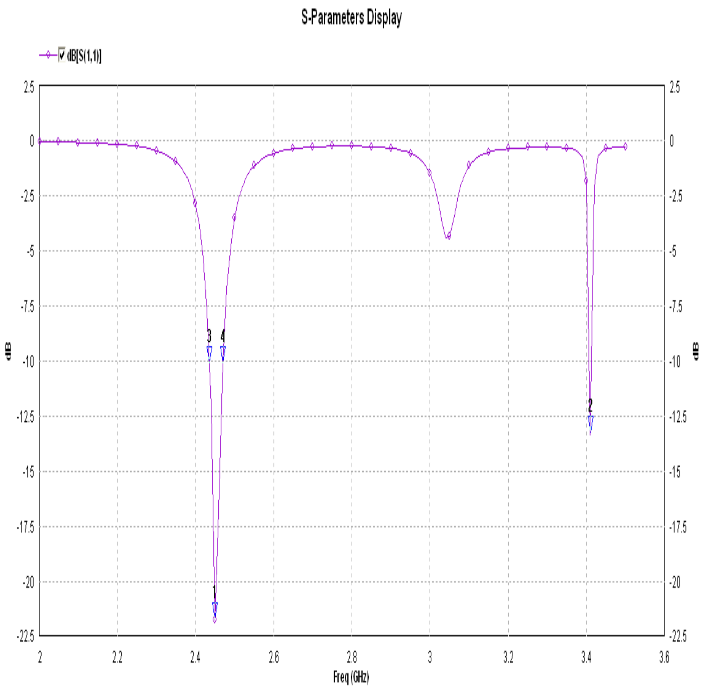


Figure 2 Return loss vs. frequency for f1 (TM_{01}) and f_2 ($TM_{o\delta}$)

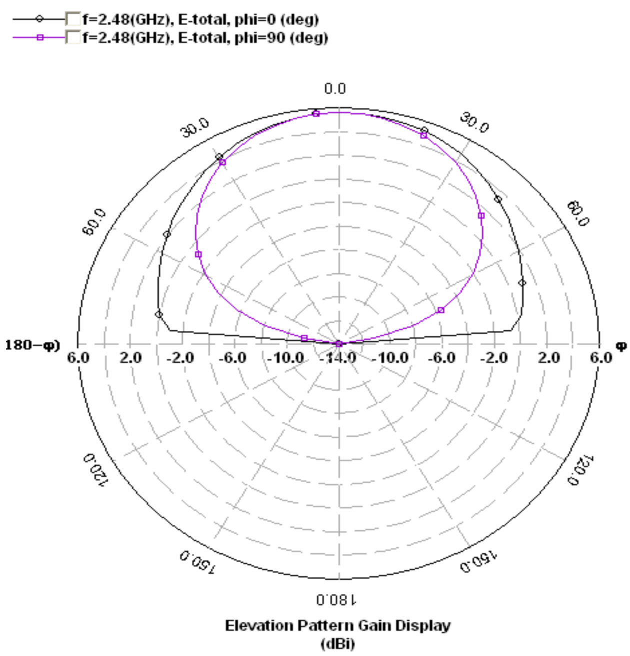
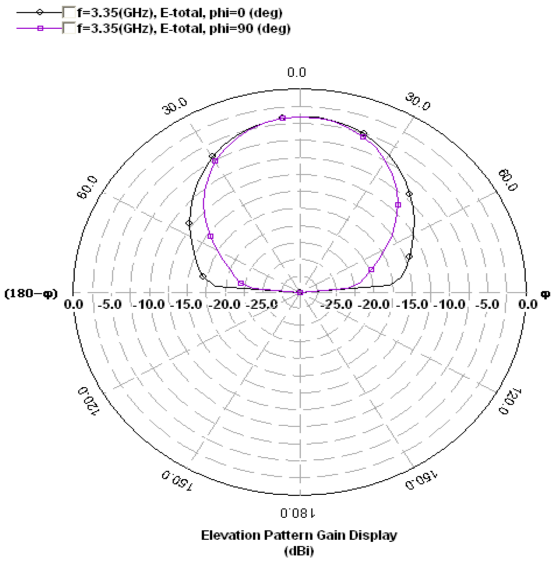


Figure 3 (a) E&H Field Radiation pattern at frequency 2.45GHz



(b) E&H Field Radiation pattern at frequency 3.4GHz

IV. CONCLUSION

A multi-slot patch antenna is proposed for multi-frequency applications. The simulation shows operation at 2.45GHz and 3.4GHz with consistency of radiation patterns. The antenna shall be suitable for Wi-Fi/ Wi-Max communication system applications.

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