Design of Planar Monopole Antenna For 2.4 GHz WLAN

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***Abstract*—T-Shape planar monopole antenna has low profile and can fed by 50 Ω microstrip line for wireless local area network (WLAN) at 2.4 GHz frequency. The design is achieved good Return loss matching for simulation and experimental result. The gain of the antenna is ≥ 4 dB and VSWR bandwidth ≤ 2. The radiation pattern and directivity of proposed antenna also presented. For analyzing the transfer function characteristics, it shows that the signal corresponding to 2.452 GHz (2.256-2.687 GHz) band serve the antenna is suitable for WLAN application.**

Keywords-Microstrip line,T-Shape antenna, WLAN.

I. INTRODUCTION

Rapid progress in wireless communication promises for replace wired communication in the near future in which antenna plays a more important role. Microstrip patch antennas are widely used because of many advantages such as low cost, low profile, compact in size and capable of operating desired Bandwidth, for these features it decreases in size of personal communication devices lead to the need of compact antennas. For high speed, broadband and high capacity of in and outdoor WLAN are more predominant today. The advantages of microstrip antenna have made them a perfect candidate for use in the WLAN application. For the available designs of monopole antennas are reported in [1-3] but the antennas are complicated in structure. So, the proposed antenna is possible to avoid these characteristics.

Recently, there is much development in order to satisfying the IEEE 802.11 WLAN standards in 2.4 GHz (2.256-2.687 GHz). Many techniques are used to reducing the size of microstrip patch antenna such as cutting slots in radiating edges [4-6], substrate with high dielectric constant and high permittivity [7-8], using the short circuit and shorting post in the patch [9-10]. For this type of designing it is generated some resonance modes for operating the desired frequencies.

In this paper we propose a novel single-frequency T-shaped monopole planar antenna fed by microstrip line suitable for WLAN operation in the 2.4-GHz (2.256-2.697GHz) band. This antenna consist gain at the direction of WLAN 2.4 GHz band. The measured return loss is presented to understand the antenna is working on the suitable frequency range. Also the input pulse signal at the transmitting antenna terminal and the far-field electric field intensity are carried out with CST microwave studio software.

II. ANTENNA DESIGN

The planar monopole T-shape antenna is shown in fig. 1 constructed on FR4 substrate of thickness 1.6 mm and relative permittivity 4.4, which has dimensions of 50 × 50 mm (W×L). In other side the ground plane is printed in back side of the substrate, below the microstrip line dimension of 50×25 mm ($W_g \times L_g$).The width (W_f) and length (L_f) of microstrip line are fixed at 3 mm and 25 mm, respectively. Microstrip feed line is designed with 50 Ω impedance, calculated from (1) and (2) for ε_r= 4.4, h= 1.6 mm and Z_o=50 Ω.

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(\frac{1}{\sqrt{1+12\frac{h}{w}}}\right) \quad \ldots (1)$$

$$Z_o = \frac{120\pi}{\sqrt{\varepsilon_{eff}}\left[\frac{w}{h}+1.393+0.667\ln\left(\frac{w}{h}+1.444\right)\right]} \quad for\ \frac{w}{h} \geq 1 \ldots . (2)$$

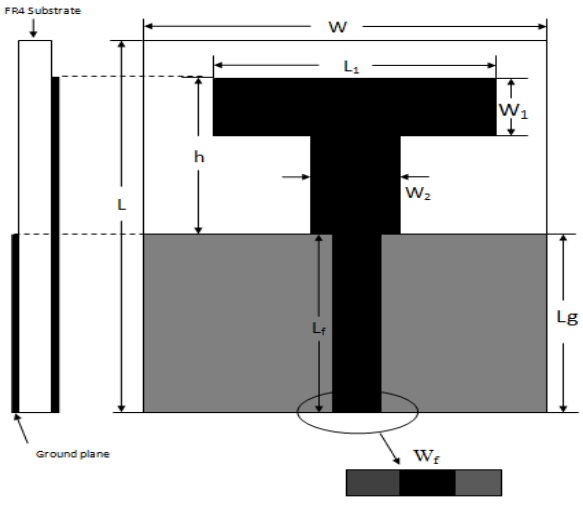


Fig.1 Geometry of Proposed Antenna

In this design, the T-shape monopole antenna height monopole antenna height h_1 on the top of the microstrip fed line. This T-shape controls the centre frequency of proposed antenna. The upper part of the T-shape is L_1 and the width

978-0-7695-4254-6/10 $26.00 © 2010 IEEE
DOI 10.1109/CICN.2010.14

is W_1, W_2 is the upper part of microstrip line which is the bottom part of proposed T-shape antenna. To achieve the desired WLAN band for 2.4 GHz, we can adjust the parameter (h, L_1, W_1 and W_2) of the patch and simulated with the help of CST microwave Studio [10]. The ground-plan dimension can also affects the resonant frequencies and the operating bandwidth.

III. Simulation and Experimental results

In fig. 2 shows the simulation and measured return loss (S_{11}) of constructed proposed antenna. The measured is agreed with the simulated result obtained with CST microwave Studio [10] of T-shape antenna for WLAN application. The -10 dB return loss was measured in E5071C network analyzer in the range of 1.5 to 3.5 GHz frequency it shows good match at the centre frequency 2.45 GHz (2.256-2.687GHz) band.

For system transfer function in fig. 3, parameter S_{21} of two port networks was simulated with face to face orientation antenna pair it is showing the path loss of proposed antenna. Linear phase of S_{11} is important parameter of WLAN applications because it shows the short pulse distribution in desired frequency range. However, the T-shape antenna at centre frequency of 2.452 GHz having a linear phase and no distortion occurs in desired bandwidth shown in fig. 4. The VSWR < 2, is also achieved at this frequency range.

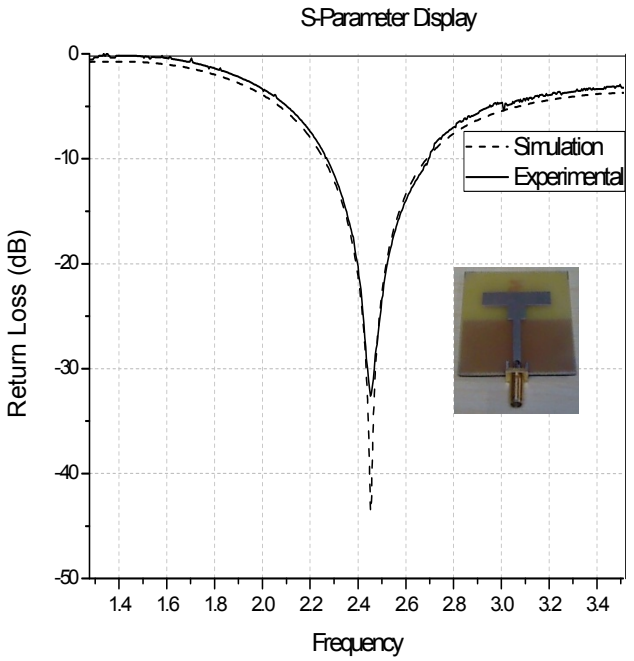


Fig. 2 Return loss Vs Frequency (S_{11})

Fig. 5 shows the directivity and gain of the proposed antenna. Gain of the proposed antenna at frequency 2.452 GHz is ≥4 dB. Directivity is 2.73 dB at the centre frequency inside the 3-dB directivity band. Since the gain and directivity of antenna match well in this frequency.

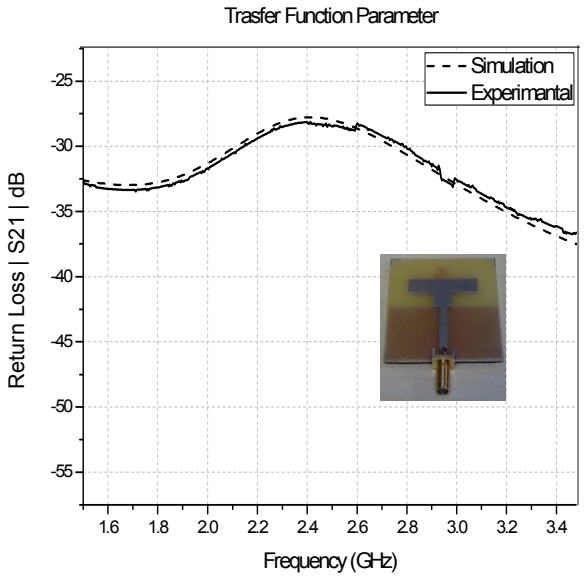


Fig. 3 Magnitude of Transfer parameter (S_{21})

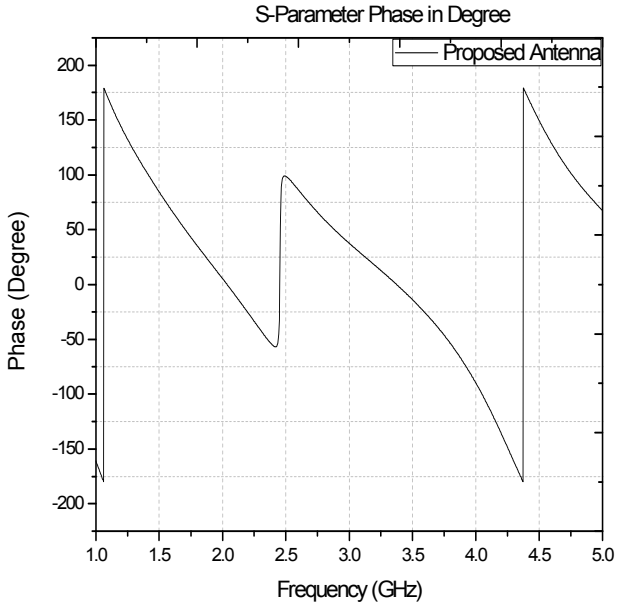


Fig. 4 Phase (Degree) Vs Frequency

The simulated radiation pattern of proposed T shape monopole antenna is shown in fig. 6 at the frequency of 2.452 GHz. Radiation pattern main cuts (φ=0° , φ=90° , θ=0°) of antenna is shown. The pattern is monopole like pattern. In T-shape antenna E-plane, the 3 dB beamwidth is 82° at frequency 2.452 GHz.

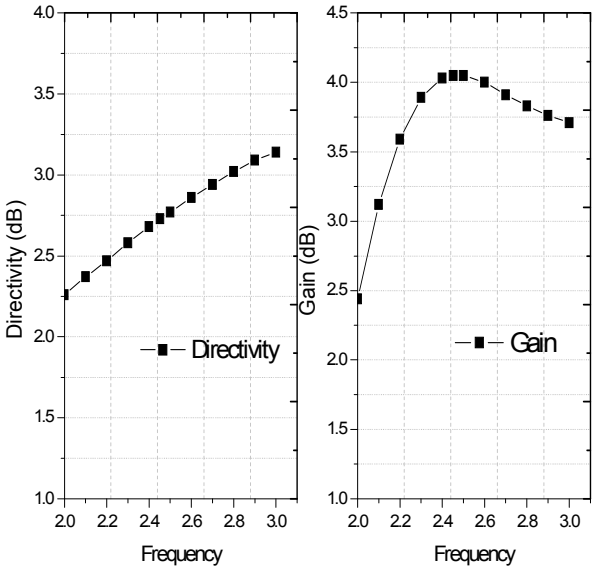
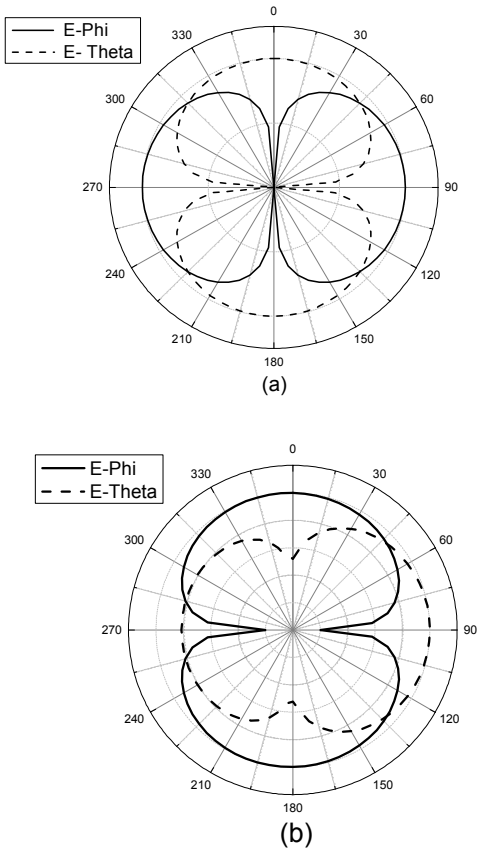


Fig. 5 Gain and Directivity of the proposed antenna



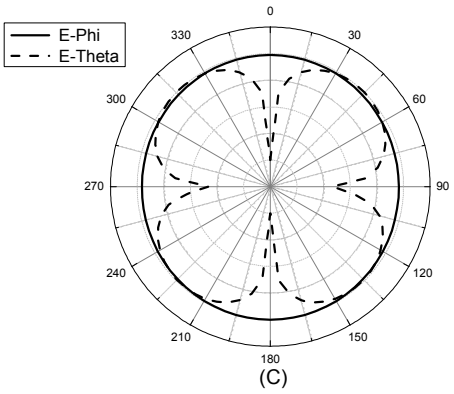


Fig 6 (a) φ=0° cut of radiation pattern (b) φ=90° cut of radiation pattern (c) θ=0° cut of radiation pattern.

IV. CONCLUSION

A planar monopole T-shape antenna with WLAN application for 2.4 GHz (2.256-2.697GHz) is presented in this paper. The design is achieved good Return loss match and linear S_{11} phase on desired centre frequency of 2.452 GHz for 50 Ω feed port (-10 dB). The bandwidth of proposed antenna is 431 MHz The antenna gain, directivity and radiation pattern are suitable for WLAN application. For pulse distribution, transfer parameter shows good performance of frequency range at both simulation and experimental. With further optimization, this antenna can be used in WLAN system at 2.452 GHz.

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