INVESTIGATION OF DUAL MEANDER SLOT TO MICROSTRIP PATCH ANTENNA

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Abstract

A dual microstrip meander slot antenna is presented for Wireless Local Area Network (WLAN) application. The proposed antenna comprises a rectangular microstrip patch element embedded with two meander slots. The parametric study is performed to investigate the characteristics of microstrip patch antenna with double meandered slots compared to one without any meander slot. Microstrip patch antenna with dual meander slot can achieve return loss until -24.54dB. However, the gain of dual meander slot antenna is lower than the rectangular antenna. Other antenna parameters are also has been investigated such as bandwidth, radiation pattern and and directivity throughout simulation and measurement process. The proposed antenna has been designed and simulated by using CST Studio Suite 2010.

Keywords - CST Studio Suite 2010, dual meander slot, microstrip patch antenna, rectangular microstrip antenna, WLAN.

1 INTRODUCTION

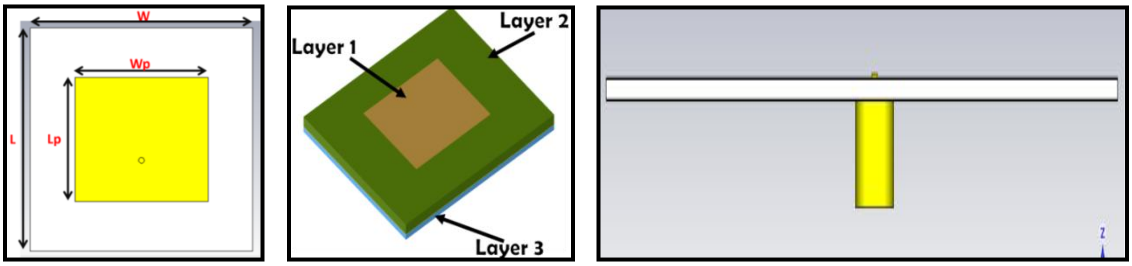
Meander line antenna is one of the types for microstrip antennas [1]. Meander line antenna allows the antenna size to be compact and perform wideband characteristic [2]. Having advantage to miniaturize antenna like other proposed methods in [3][4][5], slotted meander line antenna is chosen because of its ability to reduce the size of antenna. It is smaller and very flexible to be shifted or relocated [6]. Various factors could influence the performance of slotted meander line antenna; the position and number of turn of the meander slots, number of meander slots existed and parasitic element added [7].

A microstrip antenna has been used to investigate the effect of dual meander slot to a conventional rectangular microstrip patch antenna. Microstrip antenna was chosen because of its numerous advantages including easy integration with circuits, low cost, low profile and easy to fabricate. However, it still has drawbacks of narrow bandwidth [8]. Microstrip antenna managed to generate various patterns of polarizations including x-linear and x-circular [9][10]. The slotted meander line antenna has been designed to operate at 2.4GHz which covers the industrial, scientific and medical radio bands under WLAN interoperability [11]. Meanwhile, a probe or coaxial connector is used to be the feeding method because it is easy to be fabricated and has low spurious radiation.

2 ANTENNA DESIGN

2.1 Rectangular Microstrip Patch Antenna

The geometry for the slotted meander line antenna consists of 3 layers which are patch (Layer 1), dielectric substrate (Layer 2) and ground plane (Layer 3) as shown in Fig. 1. The antenna was simulated on FR4 substrate with dielectric constant of 4.4 and thickness of 1.6 mm. While the upper and bottom layer for patch and ground plane used material from the copper annealed with thickness of 0.035 mm. The ground also consists of SMA connecter which used as RF connecter to connect the 50 Ω coaxial cable and the 50 Ω microstrip lines on a board. The geometry of the microstrip patch antenna is shown in Fig. 1. The basis of the antenna structure is chosen to be a rectangular patch element with dimensions of width W_p and length L_p.



(a) (b) (c)

Fig. 1: Structure of microstrip antenna; (a) Front view (b) Perspective view (c) Side view

Patch length and width are calculated by using transmission line model. Formula for patch width and length [12,13] is given by equation (1) and equation (2).

$$W = \frac{1}{2f(\sqrt{\varepsilon_0 \mu_0})}\sqrt{\frac{2}{\varepsilon_r + 1}} \qquad (1)$$

$$L = \frac{1}{2f(\sqrt{\varepsilon_{eff}})} - 2\Delta L \qquad (2)$$

Parametric study method is used to obtain the best dimension of microstrip patch antenna to achieve 2.4GHz operation.

2.2 Meander Slot Antena

A. Slotted Meander Line Antenna Design Parameter

Fig.2 below shows the parameters of the meander slot that will be used in the design of dual meander slot antenna. Basically it consists of the width of horizontal length W_H, length of horizontal line L_H, width of vertical line W_V, length of vertical line L_V and the number of turn, N. For all designed structure, the width of the horizontal line, W_H is fixed to 1mm.

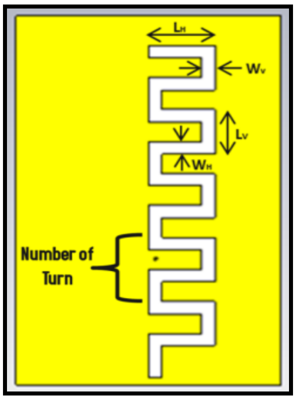


Fig. 2: Design parameter of slotted meander line antenna

B. Dual Meander Slot Antenna

Design of dual meander slot antenna in Fig. 3 consists of 3 meander slots which have been combined to form a single ‘U’ shaped of meander slot. Another meander slot is added at top of the ‘U’ shaped meander slot.

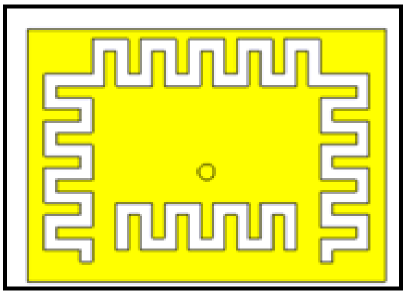


Fig. 3: Design of double meander slot antenna

3 EXPERIMENTAL RESULTS AND ANALYSIS

The simulation results are separated between rectangular microstrip patch antenna and single meander slot antenna to be compared. Return loss, bandwidth, gain and directivity results are included.

3.1 Rectangular Microstrip Patch Antenna

A. Return Loss

From the graph shown in Fig. 4, the simulation return loss at 2.4GHz is at -14.33 dB, which meets the requirement of the design which is less than -10 dB. Meanwhile the measurement result shows that the resonant frequency shifted to the left at 2.46 GHz displaying return loss of -17.05 dB which technically is a better one compared to the simulation return loss.

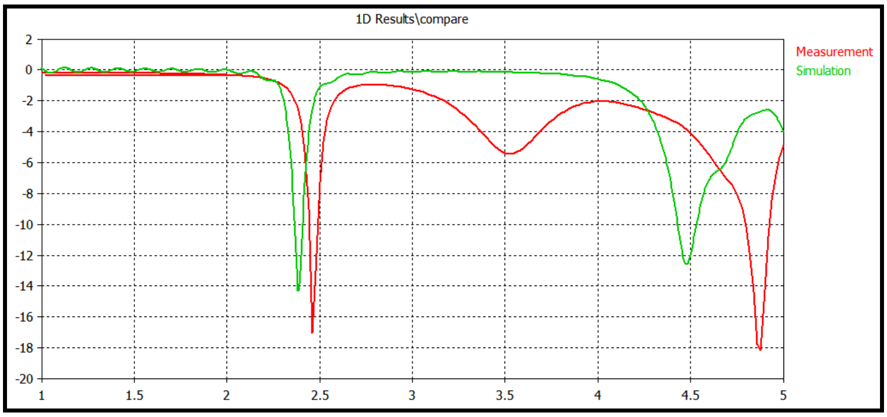


Fig. 4: Simulated and measured return loss for rectangular microstrip patch antenna

B. Bandwidth

The simulation produces a satisfactory and sufficient bandwidth to cover the 2.4GHz span of wireless LAN. This approximately 43MHz bandwidth ranges from 2.4424 to 2.4905 and was practically adequate. As for the measurement result, the value approaches 0.05GHz of bandwidth.

C. Gain and Directivity

Table 1 below shows the simulation and measurement gain of rectangular patch antenna as well as the resonant frequency, return loss and bandwidth for better comparison.

Table 1: Simulation and Measurement Result of Rectangular Microstrip Patch Antenna

Result	Frequency	Return Loss	Bandwidth	Gain
Simulation	2.4 GHz	-14.33 dB	42.68 MHz	4.23 dB
Measurement	2.46 GHz	-17.05 dB	48.08 MHz	2.67 dB

3.2 Dual Meander Slot Antenna

The results from the simulations were then validated with experimental measurements of a prototype as shown in Fig. 5.

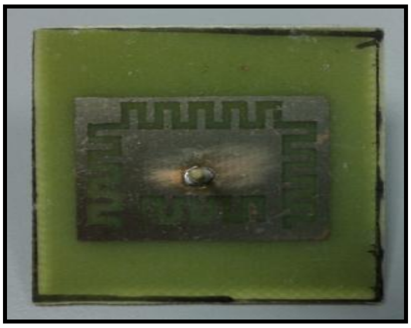


Figure 5: Antenna Prototype of dual meander slot antenna

Fig. 6 below shows the return loss of dual meander slot antenna. The simulation and measurement result is combined together for better view and comparison.

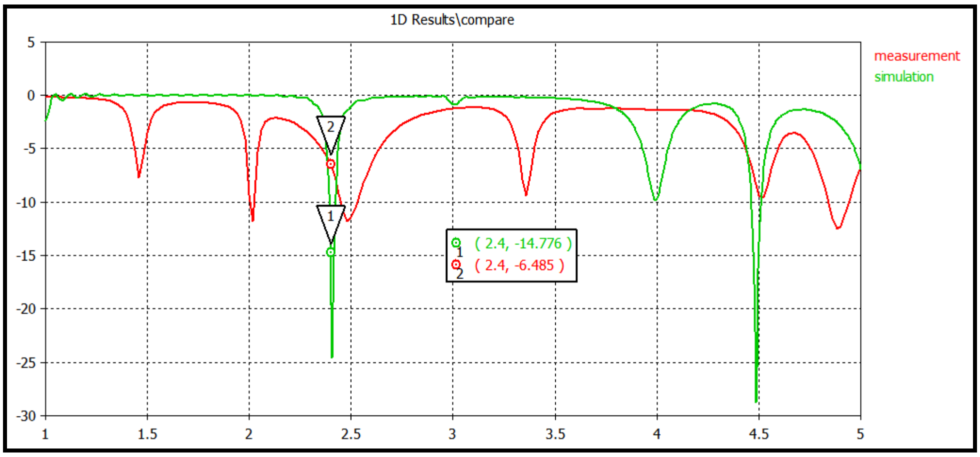


Fig. 6: Return loss of microstrip double meander slot antenna

From the graph, the dual meander slot antenna achieves return loss of -24.55 dB for simulation. It is caused by the high number of turn for the meander slot which is 13.

As for the measured result, this antenna did not able to get a return loss lower than -10dB at 2.4GHz. It only managed to achieve -6.49 dB which is not reaching the minimum 90% of antenna efficiency. The resonant frequency shifted until 2.48 GHz to get a return loss of -11.52 dB.

The bandwidth for the dual meander slot antenna is 29.48 MHz for the simulation part. The directivity for this antenna at 2.4 GHz is 5.396 dBi while the gain is 1.464 dB. The results are tabulated as shown in Table 2 below.

Table 2: Simulation and measurement result of dual meander slot antenna

Result	**Frequency**	**Return Loss**	**Bandwith**	**Gain**
Simulation	2.41 GHz	-24.54 dB	29.48 MHz	1.46 dB
Measurement	2.48 GHz	-6.49 dB	NA	-1.43 dB

While the radiation efficiency for 2.4 GHz is -3.932 dB and which is more than 50% efficiency where the antenna receives more than 50% of power transmitted. The surface current is shown in Fig. 7.

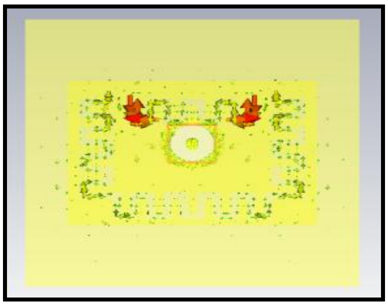
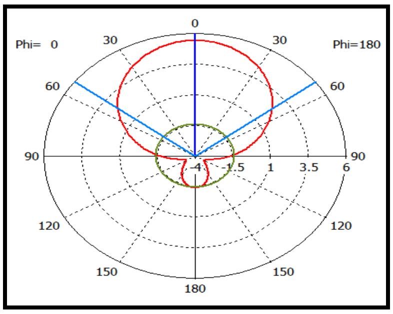
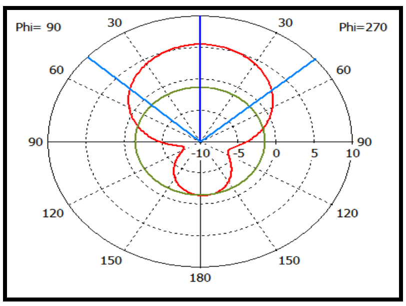


Fig. 7: Surface Current of Design 3 Antenna at 2.4 Ghz

The radiation patterns for the (total) electric field at 2.4 GHz are shown in Fig. 8. It shows that the antenna have a few nulls in the radiation patterns but holds the directional characteristics.



(a)



(b)

Fig 8: Radiation pattern at the 2.4GHz with (a) ø = 90° (b) ø = 0°

4 FUTURE WORK

The gain of this antenna is low compared to other antenna with similar structure. It can be increased by using array technique where two or more antennas are combined. Combination of these antennas can be used if properly designed which will not only enhance the gain response but also the overall directvity.

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