# MICROSTRIP DIPOLE ANTENNA FOR WLAN APPLICATION

***M.H. Jamaluddin, M.K. A. Rahim M. Z. A. Abd. Aziz, A. Asrokin***

*Wireless Communication Center (WCC),*
*Faculty of Electrical Engineering,*
*Universiti Teknologi Malaysia,*
*Email: haizal@fke.utm.my, mkamal@fke.utm.my , matjoin@yahoo.com, awi82@yahoo.com*

***Abstract—*** **This paper describes numerical simulation, fabrication and experimental measurement of microstrip dipole antenna at 2.4 GHz for WLAN application. In this antenna design, Agilent's ADS software using momentum simulation is employed to analyze the entire structure. The properties of antenna such as bandwidth, radiation pattern and half power beamwidth have been investigated and compared between simulation and measurements. The cross-polar isolation of the microstrip dipole antenna is in the range of 3 to 17.32 dB. The typical half power beamwidth (HPBW) of the microstrip dipole is 60º for E plane and 75º for H plane. Performance comparison between dipole and monopole antenna is also made in term of bandwidth and Input return loss.**

***Keywords-*** *Microstrip antenna;microstrip dipole; WLAN*

## I.INTRODUCTION

Wireless communication has developed widely and rapidly in modern world. Wireless local area networks (WLAN) are emerging technologies that will have dramatically effect in the near future. WLAN takes advantage of a license free frequency bands, Industrial, Scientific and Medical (ISM) which specify the operating frequencies as 2.4 and 5.2GHz [1-2].

Microstrip antennas are frequently used in today's wireless communication systems because of their low profile, light weight and low production cost which widely have been researched and developed in the recent twenty years [3-6]. Nevertheless, there are several disadvantages of microstrip antennas. Narrow operation bandwidth is the main disadvantage. The bandwidth of the basic patch antenna is usually 1 – 3%. The bandwidth of the antenna depends on the patch shape, dielectric constant, the thickness of the substrate and the resonant frequency [7]. The design of microstrip antennas suitable for new WLAN to achieve dual-frequency or multi-band is developed in recent years.

Microstrip dipole is a narrow microstrip conductor on the true side of the substrate, which is interrupted by a feeding gap. Microstrip dipole or printed dipole antenna has been applied in communication devices such as notebook computer and access point for WLAN operations [ 8-9].This Type of microstrip dipole antenna usually has a narrow width and in this case it can be integrated at the access point of WLAN application

## II.MICROSTRIP DIPOLE ANTENNA DESIGN

The approach proposed in this paper is to design microstrip dipole resonance at 2.4 GHz frequency band. Figure 1 shows the structure of a microstrip dipole of length ***L***, width ***W*** and gap ***G*** that were used in simulation. The proposed antenna element is printed on a FR4 substrate with a dielectric constant of 4.7, a thickness of 1.6 mm and a conductor loss of 0.019. The two hatched rectangular pieces in Figure 1 are copper on the top of the substrate. Each of it is connected with the microstrip bend. The gap between the two pieces is ***G*** and the microstrip dipole is fed at the middle of the gap. One piece of the hatched is fed with connector and another one is connected to the ground.

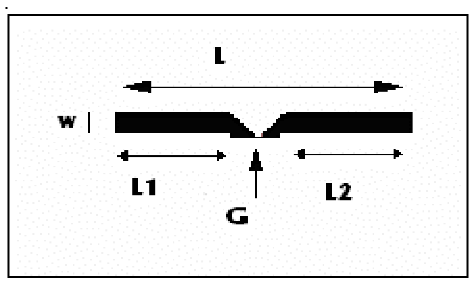


Figure 1: Microstrip Dipole Layout

Microstrip dipole of rectangular hatched or rectangular geometry as shown in figure 1 can be designed for the lowest resonant frequency using transmission line model. The formula to calculate the value of $\lambda$, $L_2$ and $W$ can be found through formulation as follows [10]:

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The effective dielectric constant ($\varepsilon_{eff}$) constant of a microstrip line:

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(\frac{1}{\sqrt{1 + 12 d/W}}\right) \quad \textbf{(1)}$$

Where

$\varepsilon_r$ = Dieletric Constant

**d** = substrate thickness

**W**= width of microstrip line (Approximation is made for the simulation)

The length ($L_1$ and $L_2$) of microstrip line using formula:

$$\lambda = \frac{c}{f\sqrt{\varepsilon_{eff}}} \quad \textbf{(2)}$$

Where λ= wavelength

**C**= velocity of light

**f** = frequency

Thus $L_1 = L_2 = \lambda/4$

The length of each hatched rectangular is about quarter-wavelength. In this case the length of rectangular hatched, $L1=L2=\lambda/4$=17 mm and the gap between the two pieces, $G$ = 0.9mm. At the designed frequency, approximation of the width $W$ is made and it is equal to 2.90 mm. Overall, the length of the dipole is about, $L$ = 40mm. In addition the microstrip bend is added between the two rectangular hatched which has length and width is equal to 2.9 mm. The photograph of the fabricated microstrip dipole prototype can be shown in figure 2.

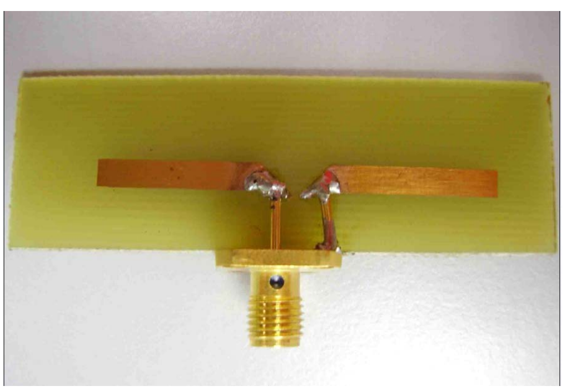


Figure 2: Fabricated Microstrip Dipole.

The design procedure of microstrip dipole antenna design can be carried out in a few steps as follows;

- The resonance frequency is chosen and for this case resonance frequency at 2.4GHz is chosen.
- Calculate the correct dipole dimension ($L_1$, $L_2$ and W) by using microstrip transmission line formula.
- Connect the rectangular hatched with microstrip bend and chooses the suitable gap G between the two hatched pieces on the substrate.
- The gap between the two traces is G and the microstrip dipole is fed at the middle of the gap.

## III. Result and Discussion

The result of microstrip dipole antenna has been discussed in term of bandwidth response, radiation pattern characteristic and cross polar isolation relative to monopole antenna. Also, the return loss for both simulation and measurement of microstrip dipole is discussed

### *A. Input Return Loss*

The measurement and simulation result of input return loss for the microstrip dipole antenna is shown in figure 3. The bandwidth from the measurement result is 22.99 % and the bandwidth using simulation result is 19.03%. The experimental result show the frequency has been shifted up slightly and the bandwidth is much greater than the simulation result. The resonance of the antenna can be seen by observing the dip in the return loss. The simulation results give a good approximation for the measurement even though the bandwidth is much lower than the simulation results.

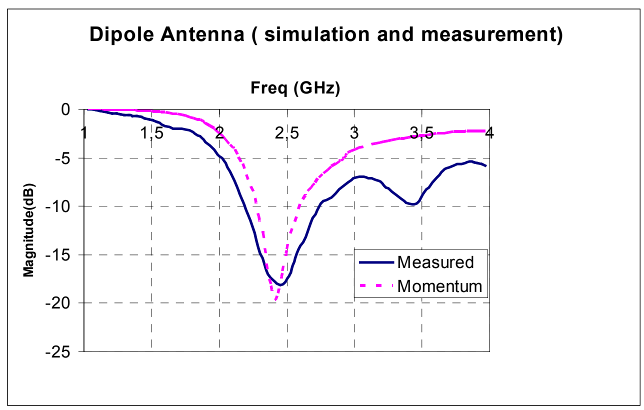



Figure 3: Input Return Loss for Microstrip Dipole Antenna.

Figure 4 shows the measurement result of input return loss for monopole and dipole antenna. The bandwidth of monopole antenna from measurement result is 8.31%. It shows that the microstrip dipole offer higher bandwidth compare to the monopole antenna.

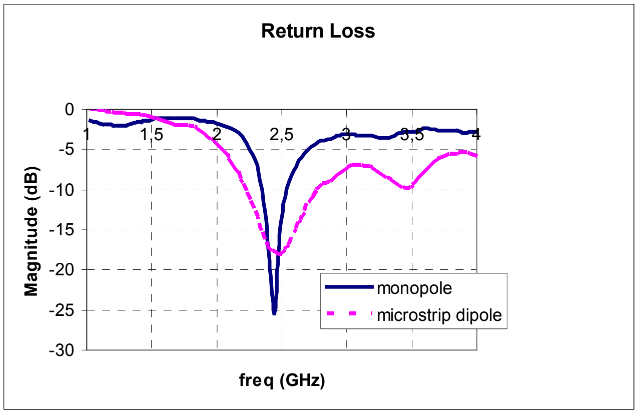
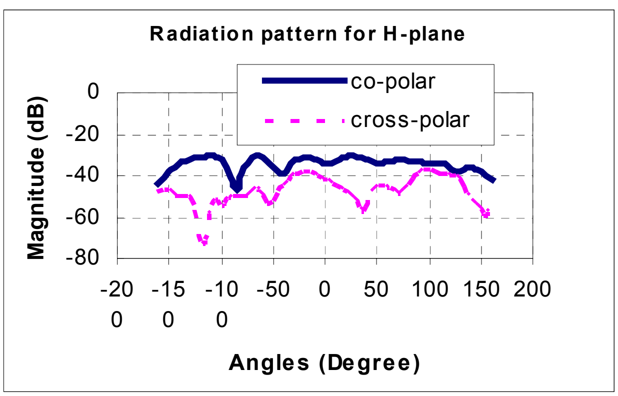


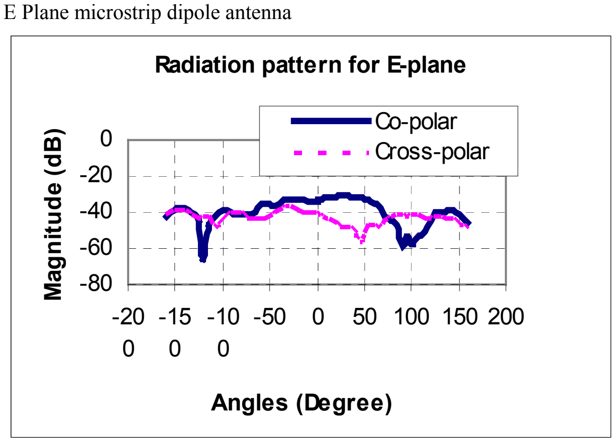

Figure 4: Input Return Loss for dipole and monopole antenna.

### *B Radiation Pattern*

Figure 5(a) and 5b) shows the radiation pattern of the microstrip dipole antenna for H Plane and E Plane at 2.4 GHz. The radiation pattern is in the broadside direction. The cross polar isolation for E Plane is 17.32 dB and for H Plane is 15.62 dB. The HPBW for E Plane is 60° and H Plane is 75°. Figure 5(c) and 5(d) show the radiation pattern of the monopole antenna for H Plane and E Plane. The cross polar isolation for monopole antenna in E Plane is 6.13 dB and for H Plane is 13.21 dB. The HPBW of the monopole antenna for E Plane is 15° and H Plane is 21°.

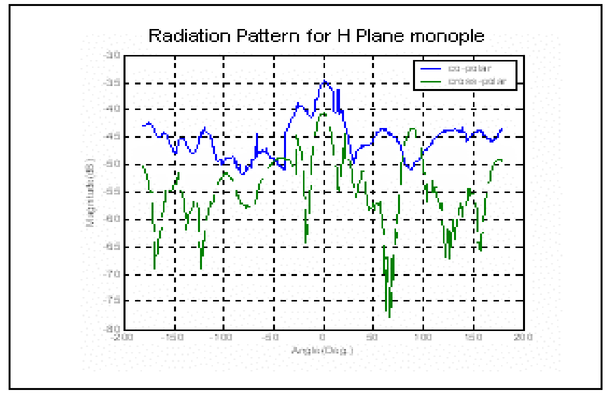



(a) E Plane microstrip dipole antenna

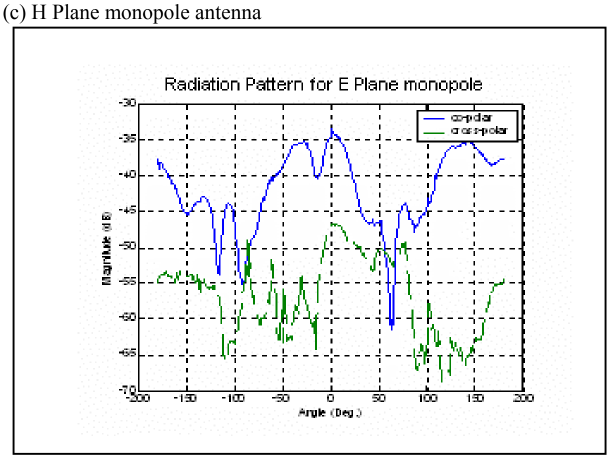



(b) H Plane microstrip dipole antenna






(c) H Plane monopole antenna




(d) E Plane monopole antenna

Figure 5: Radiation Pattern for microstrip dipole and monopole antenna.

## CONCLUSIONS

A low cost microstrip dipole antenna for WLAN operations in the 2.4GHz band has been proposed. The proposed antenna has a narrow width, and is easy to implement. By having its dipole near one half wavelengths, the antenna radiates bidirectional in the E-plane. The dipole was prototyped and tested. Measurement and simulation result was compared. The bandwidth for microstrip dipole is 14.68% greater than monopole antenna. The cross-polar isolation of the microstrip dipole antenna is in the range of 3 to 17.32 dB. The maximum cross-polar isolation can be seen at H Plane. The HPBW for microstrip dipole is 60º for E plane and 75º for H plane

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