The Study of Different Impedance Meander Line for Planar Antenna Design

#D. Misman[1], I. A. Salamat[1], M. F. Abdul Kadir[1], M. R. Che Rose[1], M. S. R. Mohd Shah[1], M. Z. A. Abd. Aziz[1], M. N. Husain[1], P.J Soh[2]

[1]*Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer*
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Hang Tuah Jaya, Ayer Keroh, 75450, Melaka, Malaysia
Email: dalila_misman@yahoo.com.my
Email : mohamadzoinol@utem.edu.my

[2]*School of Computer and Communication Engineering,*
Universiti Malaysia Perlis (UniMAP),
Kangar, Perlis, Malaysia
Email:pjsoh@unimap.edu.my

1. Introduction

Meander line technology allows designing antennas with a small size and provides wideband performance [1]. Meander line antennas (MLA) are an interesting class of resonant antennas and they have been widely studied in order to reduce the size of the radiating elements in wire antennas: monopole, dipole and folded dipole type antennas [2]. In meander line antennas, the wire is continuously folded to reduce the resonant length. Increasing the total wire length in antenna of fixed axial length lowers its resonant frequency. According to S. Best, when made to be resonant at the same frequency, the performance characteristics of these antennas are independently of the differences in their geometry or total wire length [3]. Uniform U- MLA structures, the geometry are described to 3 parameters: the number of turns, and length of the horizontal and vertical section. For NU-MLA these are no tied values for the variables [4]. In [5], compact frequency tunable planar meander line monopole antennas for mobile terminal applications are present. The operating frequency is the frequency where the reflection coefficients are less then -20 dB [6]. The good return loss for antenna is less than -10 dB [6].

2. Dimension Calculation

In this paper, the antenna designs will use microstrip technology and FR4 board for the material substrates. The dielectric constant is ε_r=4.7, loss tangent $\tan\delta = 0.019$, and the thickness *d*=1.6mm. The conductor width (*W*) of rectangular patch can be found from [7]. The calculated length and width are *L*= 61mm and horizontal length, *W*= 37mm. The value of conductor width is *W*=3mm. The effective dielectric constant of the microstrip line for *W/h* >1, $\varepsilon_r = 3.4$. The wavelength of the antenna $\lambda_o = 68mm$. The design calculation is given by [7].

3. Antenna Design: Simulated and Measured Results

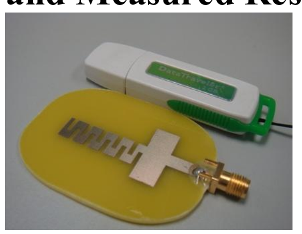

Figure 1: Photograph of the MLA

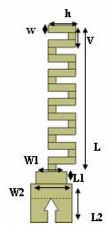

Figure 2: MLA without conductor line (Design I).

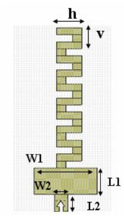

Figure 4: MLA without conductor line (Design III).

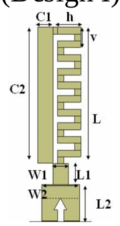

Figure 3: MLA with conductor line (Design II).

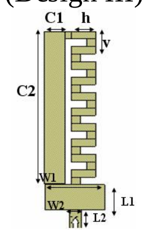

Figure 5: MLA with conductor line (Design IV).

4. Simulation Results

4.1 Impedance 50 Ohm- Planar antenna design

The investigation has been done for different type of feeding and with and without conductor line. The parameters of the meander line antenna, which is considered in this paper, are horizontal length (*h*), vertical length (*v*), and the number of turns (*N*). Fixed conductor line length (*C2*) and conductor line width (*C1*) of 59.7mm and 7.1mm are set for Design II and IV. The horizontal length of 11mm, vertical length *v* = 9 mm and number of turn *N*=5 will give the best return loss for Design I, and II. The length of horizontal *h* =8mm, vertical length *v* = 9 mm and number of turn *N*=5 produced a satisfactory frequency response at 2.4 GHz for Design III and IV.

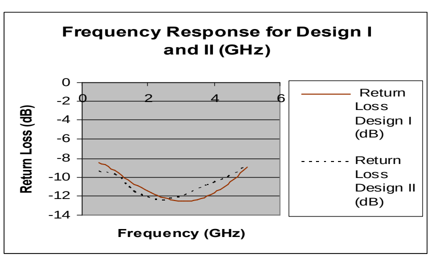

Figure 6: Frequency response for Design I and II

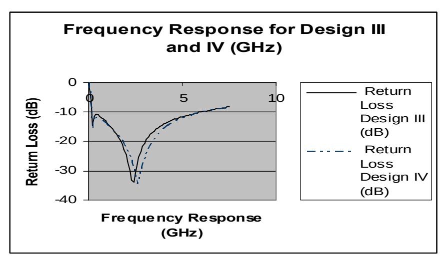

Figure 7: Frequency response for Design III and IV

Table 1: Comparison Between Four Design

Simulation Results	*h* (mm)	Frequency (GHz)	Lower n upper freq.(GHz)	RL (dB)	BW (GHz)
Design I	11	2.4	1.26-4.66	-12	3.4
Design II	11	2.4	1.12-4.4	-12.45	3.28
Design III	8	2.4	0.14-6.09	-34.93	5.95
Design IV	8	2.4	0.01-6.25	-29.97	6.24

4.2 Impedance 75 Ohm- Planar antenna design

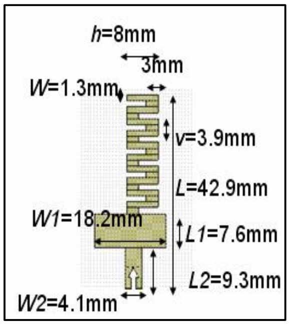

Figure 8: Antenna Dimension

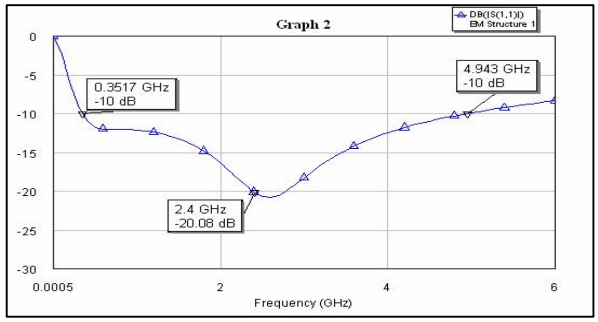

Figure 9: Simulated Frequency Response

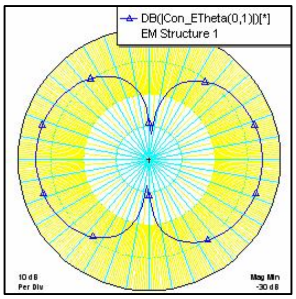

Figure 10: E-Plane

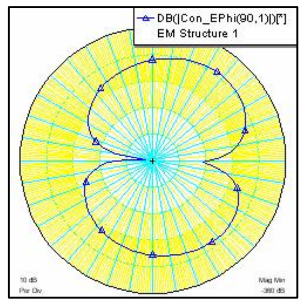

Figure 11: H-Plane

Table 2: Simulation Results (Impedance 75 Ohm)

Simulation	Design I
Frequency response (GHz)	2.4
Return Loss (dB)	-20.08
Bandwidth (GHz)	4.5 (1.89%)

5. Measurement Results

5.1 Impedance 50 Ohm- Planar antenna design

The measured result of return loss in room temperature is larger than the simulation result. This is caused by inaccuracies in the fabrication process, the effect of the SMA connector and errors in processing. The designed antenna has been fabricated by using chemical etching technique.

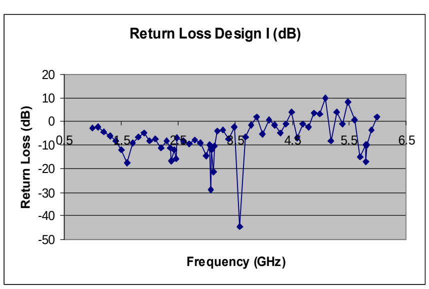

Figure 12: Frequency Response Design I

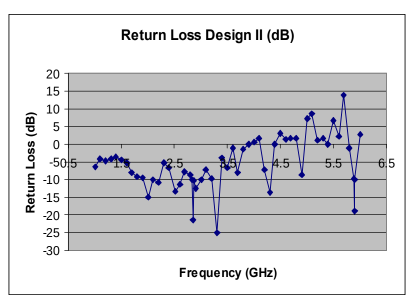

Figure 13: Frequency Response Design II

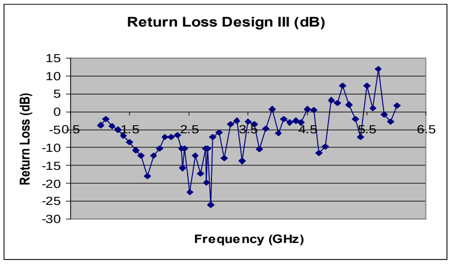

Figure 14: Frequency Response Design III

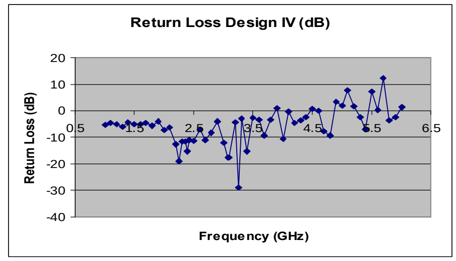

Figure 15: Frequency Response Design IV

Table 3: Measurement Results (Impedance50 Ohm)

Measurement	Design I	Design II	Design III	Design IV
Frequency response (GHz)	2.39	2.52	2.52	2.4
Return Loss (dB)	-16.5	-13.45	-22.5	-15.3
Bandwidth (MHz)	71MHz (2.98%)	38MHz (1.33%)	43MHz (1.79%)	70MHz (2.92%)

5.2 Impedance 75 Ohm- Planar antenna design

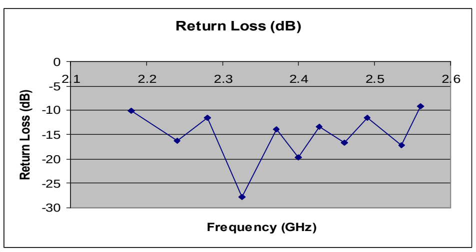

Figure 16: Frequency Response Design I

Table 4: Measurement Results (Impedance 75 Ohm)

Measurement	Design I
Frequency response (GHz)	2.4
Return Loss (dB)	-19.66
Bandwidth (MHz)	57MHz (2.38%)

6. Conclusion

The meander line antenna design with conductor line will provide better performance. The horizontal length h = 11 mm, the vertical length v = 9 mm, conductor length $C2$ = 59.7 mm, conductor width $C1$ = 7.1mm and number of turn N = 5 is chosen as the optimal dimension operation at the WLAN frequency of 2.4 GHz. The best return loss for the antenna is -19.66dB (measured) at frequency 2.4 GHz. The planar meander line antenna designs for Design I and Design IV posses a larger bandwidth. The best return loss for the planar antenna designed is -34.93 dB (simulated).

References

[1] A. Khaleghi. A. Azooulay. J. C. Bolomey, ñA Dual Band Back Couple Meandering Antenna For Wireless LAN Applicationsò, Gof Suryvette, France, 2005.

[2] H. Nakono. H. Tagami. A. Yoshizawa. and J.Yamauchi, ñShortening ratios of modified dipole antennas,ò *IEEE Trans. Antennas Propagat*. ,Vol. AP-32, pp. 385-386, Apr. 1984.

[3] S. Best, ñOn the resonant properties of the Koch fractal and other wire monopole antennas,ò *IEEE Antennas and Propagation Soc. Int. Symp*, June 22-27, 2003, pp. 856-859.

[4] Constine A. Balanis, Antenna Theory: A review,New York, Wiley, 1992.

[5] V. K. Palukuru, M. Komulainen, M. Berg, H. Jantunen and E. Salonen, ò Frequency- Tunable Planar Monopole Antenna for Mobile Terminalsò EuCAP 2007, Edinburgh, UK, November 2007.

[6] Elsherbeni, A. Z. J. Chen, C. E. Smith, and, ñFDTD analysis of meander line antennas for personal communication applications,ò Progress In Electromagnetics Research, PIER 24, 185-199, 1999

[7] Constantine A. Balanis,òAntenna theory analysis and designò, Wiley- Interscience, John Wiley & Sons, Hoboken, New Jersey.