A Printed Monopole Antenna with Symmetric Meandered Arms for WLAN, WiMAX Applications

Asit K.Panda,R.Suryanarayana,Abhishek Sahoo,Jayanta Nayak
National Institute of Science and Technology
Berhampur, India
panda.asit@gmail.com

Rabindra K.Mishra
Berhampur University
Berhampur, India
r.k.mishra@ieee.org

Abstract— **In this paper, a planar dual band symmetric Meandered Arms monopole antenna for wireless local area network (WLAN) & WiMAX applications is presented. The antenna consists of two symmetric Meandered arms radiating strip leading to generate two separate resonant modes where the first mode is for the 3.5 GHz band and the second mode is for the 5.2/5.8 GHz band operation. The purposed antenna has a measured impedance bandwidths of 3.39-3.5 GHz and 5.5-5.6 GHz, and owns good radiation characteristics impedance bandwidths, with a compact size of 30x35xl.6 mm^3.The radiation pattern and resonant frequency are mainly affected by symmetric meandered arms radiating patch and a rectangular ground plane. The CST Microwave studio is employed for designing the antenna. This purposed antenna is fed by a coaxial probe through a SMA connector.**

Keywords- ***Microstrip, dual-band, monopole, meander line, WiMAX, WLAN.***

I. INTRODUCTION

The rapid development of modern wireless communication systems has caused wide interests in designing wide-band and multi-band antennas; especially for the wireless communication system and world interoperability for microwave access (WiMAX) has more advantages on broadband speed. A number of antenna designs have been proposed for dual-band or multi-band performances to satisfy the WIFI (5.1-5.825 GHz) and WiMAX (3.4-3.69 GHz) operations. These antennas are also required with low-profile, light weight, packaged and easy integration with the Monolithic Microwave Integrated Circuits (MMICs) to fit the limited equipment space of the WLAN device, such as the planar inverted-F antennas (PIFA) [1], the microstrip slot antennas [2], the chip antennas [3], and printed monopole antennas [4],etc. Among these antennas, the printed monopole antennas with the folded structure or the meander line shape have especially received much more attention. In [4], a tapered bent folded monopole fed by a coplanar waveguide (CPW) is proposed to cover the 3.4GHz and the 5GHz WLAN bands. By using the tapered folded geometry, the antenna's impedance bandwidths have been greatly enhanced. In literature [5-7], a type of interesting printed monopole antennas with the geometry of character letters, such as F-shaped and G-shaped, etc, have been designed for WLAN application. These antennas are composed of two radiating meander strips which are controlled to operating at different bands. In this paper, a novel printed monopole antenna with symmetric meandered arms geometry is introduced for the dual-band WiMAX/WLAN operation. The proposed antenna is fed by a coaxial probe through a SMA connector to a 50 ohms microstrip with width 2 mm. In this study, several metal strips are used to form the symmetric meandered arms radiating patch and a coaxial probe is adopted to feed to antenna [3-5]. Since radiating elements of the antenna consist of many strips, the different modes would be excited and the antenna could be applied for dual-band purposes [3]. The first band of the proposed antenna with a bandwidth of 110 MHz (3390 MHz–3500 MHz) is to be used for WiMAX. The second band with a bandwidth of 114 MHz (5493 MHz–5607 MHz) is to be used for WLAN applications. The proposed antenna has good radiation pattern that corresponds the resonant frequency.

II. ANTENNA CONFIGURATION

Figure 1 show the designed process of meandered arms and the geometry of the proposed antenna. The antenna consists of two symmetrical meandered arms. The meandered arm consists of two bend strips with the same width and lengths. At first, we design meandered arm 1 of length L and width W2 as shown in Fig.1 (a) followed by symmetrical meandered arm2 as shown in 1(b) and connect the lower ends of both the patch by a strip as shown in Fig. 1 (c). The longer radiating strip (donated Strip W) resonates at the higher frequency and the shorter radiating strip (denoted strip W1) at lower frequency band.

In this novel design, the symmetric meandered arm monopole antenna is presented. The proposed monopole antenna prototype illustrated in Fig. 2. It was designed on FR-4 substrate with thickness of the substrate = 1.6 mm. (1/16”), ε_r=4.4 & tan (δ) =0.019 respectively. The structure was fed through a 2.0 mm diameter, 50Ω coaxial probe with a SMA connector on the bottom side of the plane. The total antenna dimension is 30 x 35 mm^2.

978-0-7695-4437-3/11 $26.00 © 2011 IEEE
DOI 10.1109/CSNT.2011.55

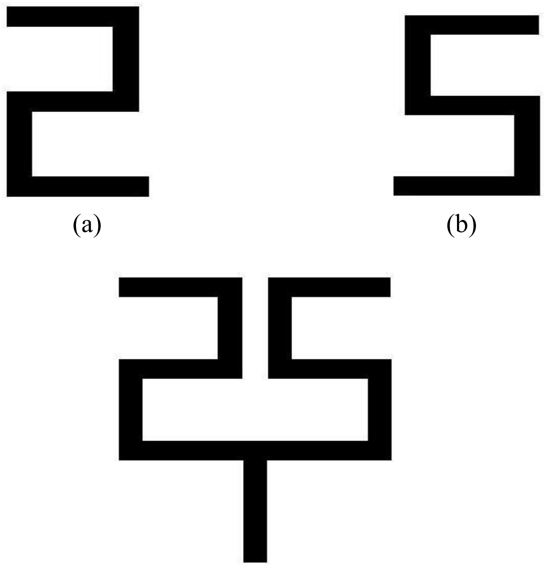


Fig. 1. The designed process of the letters into the proposed antenna structure.

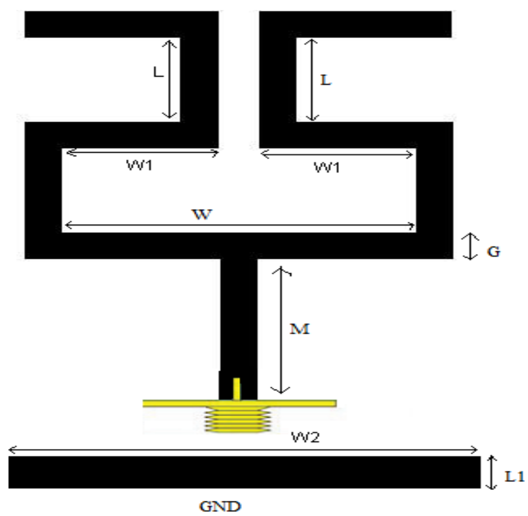


Fig. 2. Geometry of proposed antenna

The Dimensions of the designed antenna are
L = 6 mm, W = 18 mm, G = 1.5 mm, Ls = 16 mm,
L_1 = 1 mm, W_2 = 40 mm respectively.

The input return loss of the proposed antenna is simulated using an electromagnetic solver CST Microwave Studio.

III. RESULT AND DISCUSSION

A. Return Loss Characteristics

The proposed antenna is simulated & analyzed using CST Microwave studio (CST MWS) & verified using IE3D between the frequencies 2-7 GHz. From return loss characteristic graph it is found that the antenna is matched in two resonating frequencies. A prototype was constructed according to the design dimensions, and the simulation return loss is shown in Fig. 3, which shows that the antenna is suitable for WIFI and WiMAX applications. Two resonating modes at 3.4 and 5.31 GHz can be clearly observed and the return loss in all 2 bands is very good The first impedance bandwidth at 3.4 GHz is 110 MHz (3.35-3.50 GHz), covering the WiMAX (3.4- 3.69 GHZ) band with return loss -18 dB better than -10 dB. The second bandwidth at 5.55 GHz is 114 MHz (5.49-5.6 GHz), covering the WIFI (5.1-5.825 GHz) band with return loss -34.5 dB.

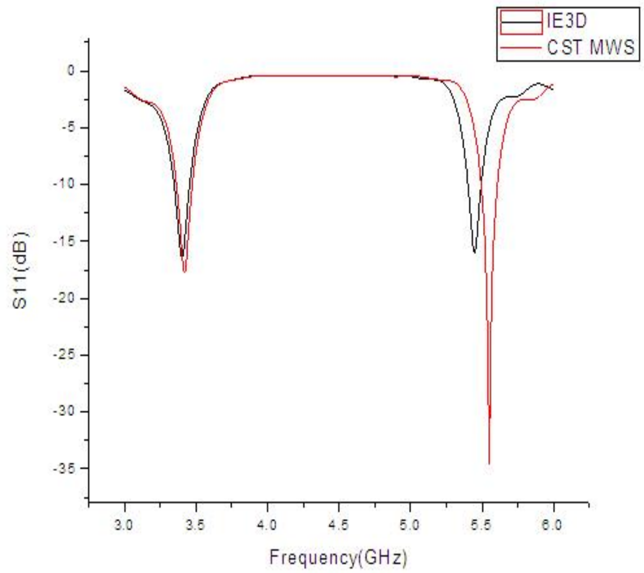


Fig.3. Return Loss of purposed symmetric meandered arm monopole antenna using CST MWS & compare with IE3D

TABLE I
Frequency Band, Return Loss and Bandwidth

Band	f(GHz)	S11(dB)	BW (MHz)
M1	3.4	-18	110
M2	5.5	-34.5	114

As observed in fig.4, gain vs. frequency plot, it is found that the gain is around 3.4 dB at lower frequency band and around 4.8 dB at higher frequency bands.

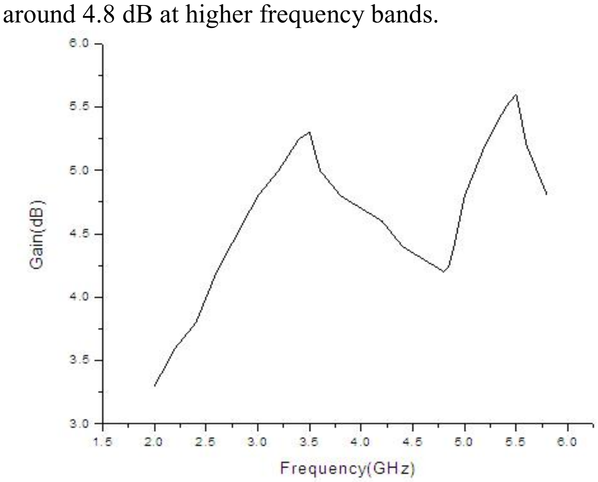


Fig. 4. Gain Vs frequency

B. Effects of design parameters

It has been noticed in the simulation that the operating bandwidth of the printed symmetric Meandered Arms monopole antenna is critically dependent on the width of the antenna (G), and the length of the central conductor (Ls). So these parameters are needed to be optimized for maximum bandwidth and gain.

a) The Effect of meandered arm width(G)

Fig. 5 depicts the simulated return loss curves for different meandered **arm widths** (G=1.5, 2, and 2.5 mm).When W is fixed at 18 mm and *L* at 6 mm, respectively. It is noticed that the return loss curves vary significantly for the three different values of G. But when the width increases, there is change in the bandwidth and the return loss. The optimal antenna **width** for required bandwidth application usage is found to be at G = 1.5 mm.

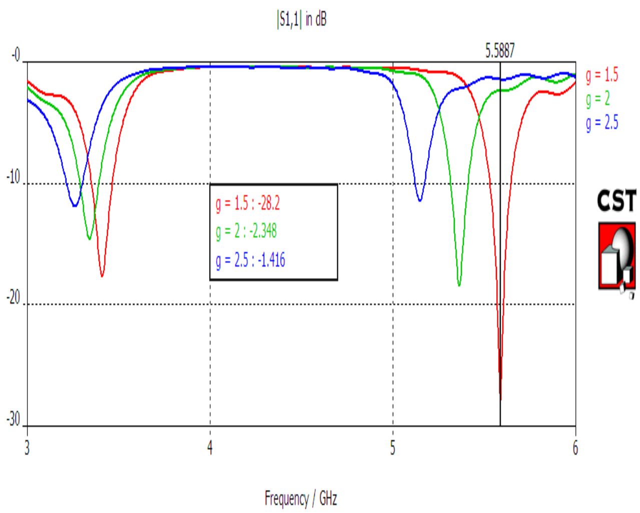


Fig.5 Simulated return loss curves for different arm width G = 1.5 mm, 2 mm and 2.5 mm

b) The Effect of length of central conductor(Ls)

The simulated return loss curves with *G* = 1.5 mm and antenna width W =18 mm for different **lengths of central conductor** are illustrated in Fig. 6. When Ls increases from 14 mm to 16 mm the impedance matching of the antenna gets better, however the lower edge of the bandwidth decreases. This fact gives further indication that a better impedance matching can be obtained for **Ls=16**.

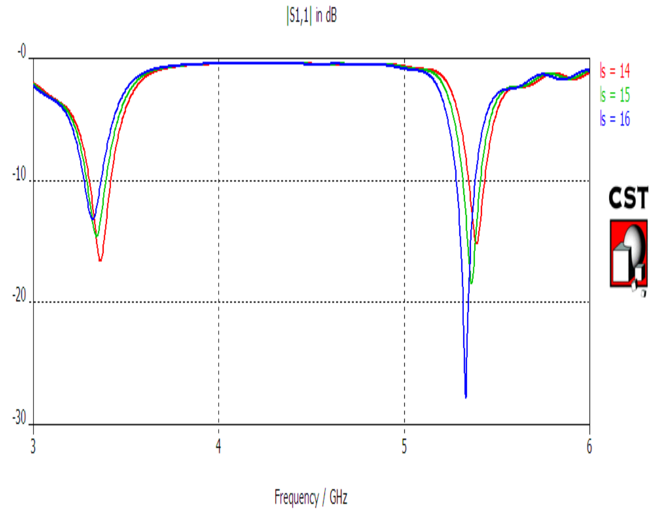
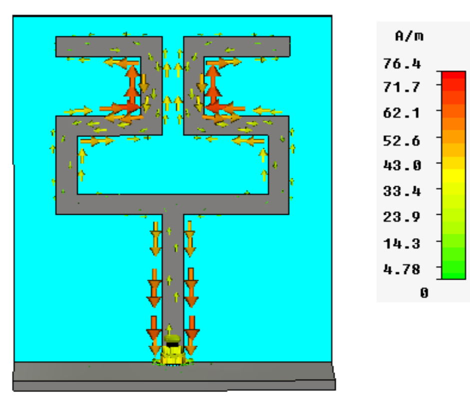


Fig.6 Simulated return loss curves for different central conductor lengths Ls = 14mm, 15mm and 16 mm.

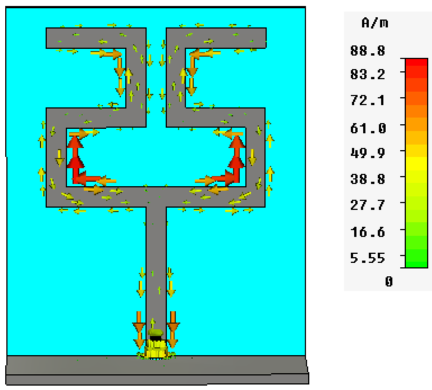
C. Current distribution & Radiation pattern

The current density and radiation patterns are analyzed using CST MWS. With a series of simulations it is seen that the magnetic current at the central gap & the electric current on the patch region of the antenna around the gap is crucial for resonance & radiation characteristics of such antenna. Simulated current density on the surface of the antenna at 3.4 GHz & 5.55 GHz is shown in figure 7.

This gives insight into the manner in which antenna radiates at two bands. It is seen that the current distribution is splitting around the central region as it moves from lower band of 2.35 GHz to higher bands 5.5 GHz



(a)



(b)

Fig.7. Simulation Current density distribution on monopole antenna surface at (a) 3.4GHz, and (b) 5.5 GHz

Simulated Meandered Arm monopole Antenna Elevation pattern (E-θ) at all distinct frequencies for $\varphi = 0^0$ & 90^0 at 3.4 GHz, and 5.55 GHz. are shown in Fig.8. The radiations show nearly omni-directional pattern in the azimuth plane (x-y plane) and glass-like patterns in the elevation planes (x-z or y-z plane).A lack of polarization purity is observed in the figure. As a matter of fact, this is not a drawback since the urban communication environments are so complicated that both vertical and horizontal polarization may exist.

IV. CONCLUSION

In this paper we present a novel design of a compact printed dual-band monopole antenna with symmetrical meandered arms capable of wireless applications. Simulated results indicate that the antenna exhibits a good return loss, and the antenna gain is above 5 dB at the designed frequency the antenna meets the demand of WiMAX/WLAN dual-band operation. Nearly omni-directional radiation pattern characteristics across the impedance bandwidths have been observed.

ACKNOWLEDGMENT

The authors would like to thank CST Company, India for their support in CST EM tool. The authors are also grateful to the anonymous reviewers for their constructive and helpful comments & suggestion.

REFERENCES

[1] C. W. Chiu and F. L. Lin, “Compact dual-band PIFA with multi-resonators,” Electron. Lett., vol. 38, no. 12,pp. 538-540,Jun. 2002.

[2] M. K. Karkkainen, “Meandered multiband PIFA with coplanar parasitic patches,” IEEE Microw. Wireless Compon. Lett., vol. 15, no. 10, pp. 630-632, Oct. 2005.

[3] parasitic patches,” IEEE Microw. Wireless Compon. Lett., vol. 15, no. 10, pp. 630-632, Oct. 2005.

[4] H. M. Chen, Y. F. Lin, C. C. Kuo and K. C. Huang, “A compact dual-band microstrip-fed monopole antenna,” 2001 IEEE AP-S Int’l. Symp., Boston, U.S.A., vol. 2, pp. 124-127, July 8-13, 2001.

[5] W. C. Liu, W. R. Chen, and C. M. Wu, "Printed double S- shaped monopole antenna for wideband and multiband operation of wireless communications," IEE Proceedings in Microwaves, Antennas and Propagation, vol. 151, pp. 473-476, Dec. 2004.

[6] [5] J. Qiu, Z. Du, J. Lu, and K. Gong, “A planar monopole antenna design with band-notched characteristic,” IEEE Trans. Antennas Propag., vol.54, no. 1, pp. 288–292, Jan. 2006.
K.-L. Lau, P. Li, and K.-M. Luk, “A monopole patch antenna with very wide impedance bandwidth,” IEEE Trans. Antennas Propag., vol.53, no. 2, pp. 655–661, Feb. 2005.

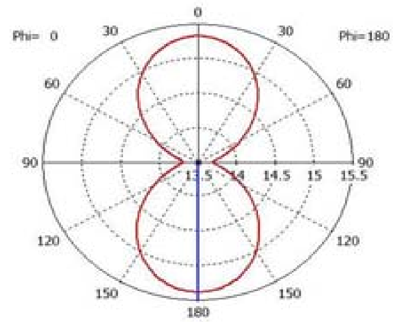


Fig. 8 (a). E- θ for $\varphi=0^0$ at f = 3.4 GHz

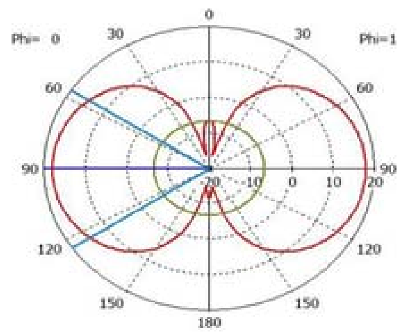


Fig. 8(b) E-θ for $\varphi=90^0$ at f = 3.4 GHz

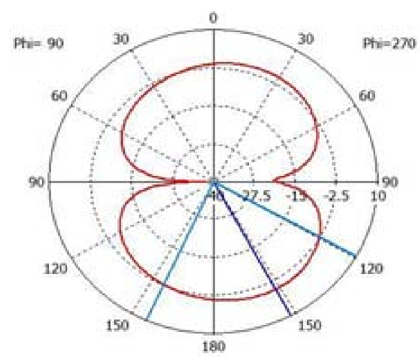


Fig. 8(c). E- θ for $\varphi=0^0$ at f = 5.55 GHz

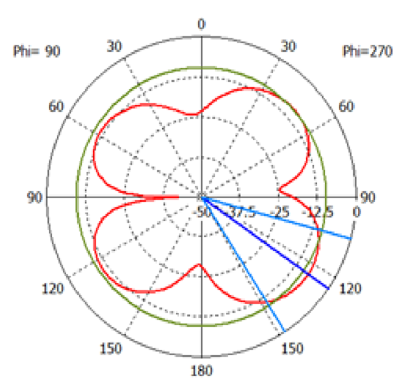


Fig. 8(d) . Elevation E- θ for $\varphi=90^0$ at f = 5.55 GHz