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High efficient PIFA-L Bend antenna for MIMO based Mobile Handsets

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Abstract: *This prototype is based on designing and analysis of size optimized planar inverted-F antenna (PIFA) with L bend element, accommodated on a printed circuit board (PCB) for mobile handsets and operating at 2.68GHz.This antenna have a principle advantage of reduce size, low cost manufacturing, high bandwidth utility. Different parametric analysis has been performed with the handset dimension of about 100x40 mm. The antenna design and simulations are done using HFSS.*
Keywords: PIFA-L, HFSS, FR4substrate**,**

I. Introduction

PIFA can be considered as a kind of linear Inverted F antenna (IFA) with the wire radiator element replaced by a plate to expand the bandwidth [1].The Planar Inverted-F antenna (PIFA) is increasingly used in the mobile phone market. The antenna is nearly resonant at the quarter wavelength thus reducing the required space needed on the phone, and also typically has good SAR properties [3].

The general structure of PIFA antenna is given in Fig 1.
The PIFA is designed to operate at 2.68 GHz by the equation in (1):

$$fr = c\,[4\,(W + L)]^{-1} \qquad (1)$$

Where, c is the velocity of light. fr, W and L are, respectively be the width, length and centre frequency as given in Table 1.

General PIFA dimensions

One method of reducing PIFA size is simply by shortening the antenna. However, this approach affects the impedance at the antenna terminals such that the radiation resistance becomes reactive as well. This can be compensated with capacitive top loading. In practice, the missing antenna height is replaced with an equivalent circuit, which improves the impedance match and the efficiency [2].

The capacitive loading reduces the resonance length from λ/4 to less than λ/8 at the expense of bandwidth and good matching [5]. The capacitive load can be produced by adding a plate (parallel to the ground) to produce a parallel plate capacitor as show n in Fig 2.

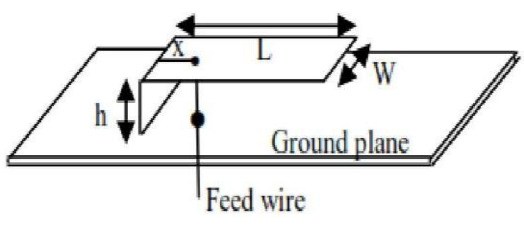

Fig 1: The Planar Inverted-F Antenna (PIFA).

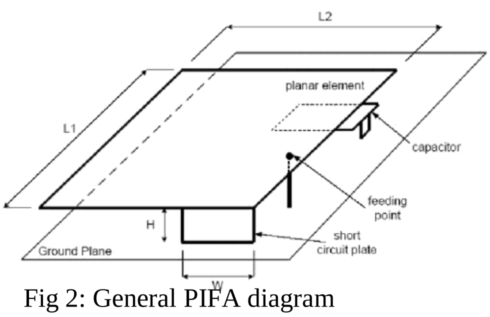

Fig 2: General PIFA diagram

II. Material Considerations.

The metallic patch is normally made of thin copper foil. The substrate material provides mechanical support for the radiating patch elements. It also maintains the required spacing between the patch and its ground plane. The substrate thickness for the basic geometry is in the range of 0.01 to 0.05 free-space wavelength. The dielectric constant ranges from 1 to 10 and can be separated into three categories.

1. Those having a relative dielectric constant (relative permittivity) in the range of 1.0 to 2.0. This type of material can be air, polystyrene foam, or dielectric honeycomb.
2. Those having a relative dielectric constant in the range of 2.0 to 4.0. This type of material consists mostly of Fiber-glass reinforced Teflon.
3. Those with a relative dielectric constant between 4.0 and 10.0. This type of material can be ceramic, quartz, or alumnia.

The most commonly used material is Teflon-based with a relative permittivity between 2 and 3. This material is also called PTFE (PolyTeraFluoroEthylene). It has a structure very similar to fiberglass material used for digital circuit boards, but has a much lower loss tangent. Cost, power loss, and performance are trade-o considerations in choosing the substrate material, as illustrated by the following examples [6]. For example, a single patch or an array of a few elements may be fabricated on a low-cost fiberglass material at the L-band frequency, while a 20-element array at 30 GHz may have to use higher-cost, but lower loss, Teflon-based material (loss tangent less than 0.005). For a large number of array elements at lower microwave frequencies (below 15 GHz), a dielectric honeycomb or foam panel may be used as a substrate to minimize loss, antenna mass, and material cost while having increased bandwidth performance. There are materials with relative dielectric constant higher than 10. The patch size is smaller for higher dielectric constant. However, higher dielectric constant also reduces bandwidth and radiation efficiency [4].

III. Proposed Antenna Structure And Design Data.

The PIFA-L antenna structure is based on the PIFA antenna design, its design data is given in Table 1.

PIFA-L DESIGN DATA	
Parameters	mm
Solution frequency(GHz)	2.68
Antenna length 1	21.86
Antenna length 2	7.02
Antenna trace width	1.32
Antenna offset `	3.95
Feed offset	-4.39
Feed length	0.132
Feed width	1.32
Substrate thickness	62mil
Substrate dimension along x	43.9
Substrate dimension along y	87.8

Table 1: PIFA- L DESIGN DATA

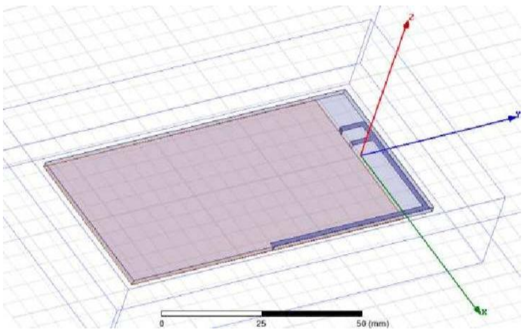

Fig 3: PIFA-L ANTENNA MODEL

IV. Simulated Results

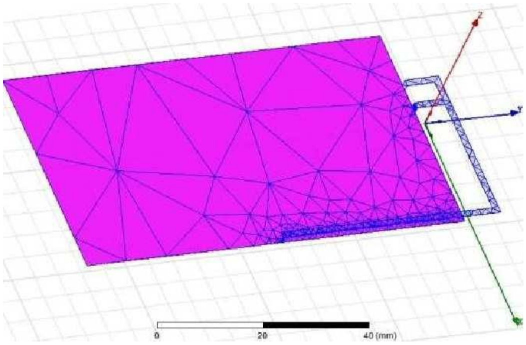

Fig 4: Return loss

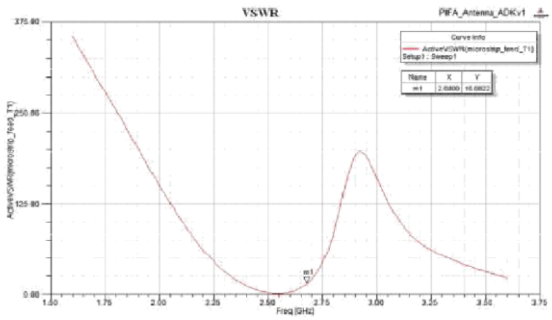

Fig 5: VSWR

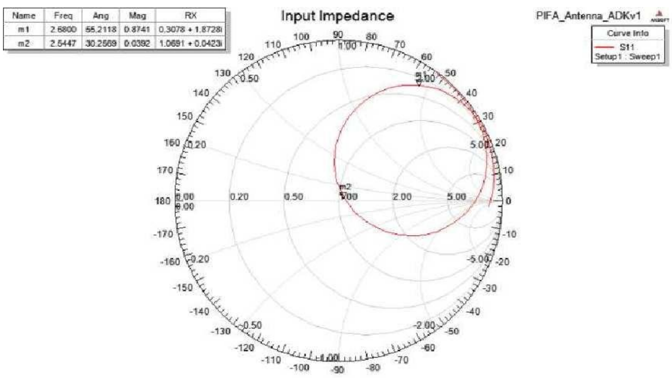

Fig 6: Input Impedance

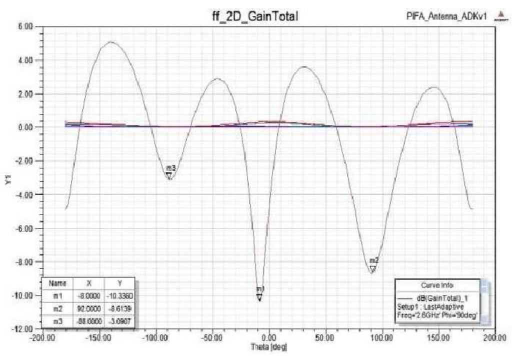

Fig 7: 2D Total Gain

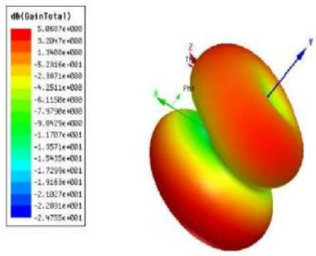

Fig 8: 3D Total gain

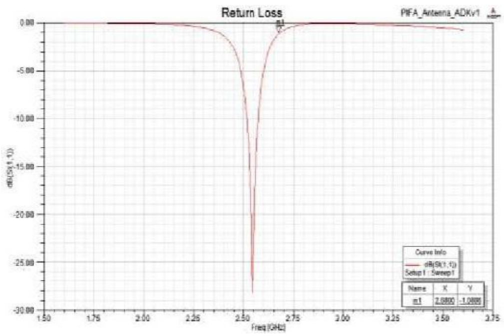

Fig 9: Mesh analysis

In Fig 3 the PIFA L- Bend structure is designed using Ansoft HFSS software simulator, the design specifications are given in Table 1. The design is performed with a virtual radiation of outer box which covers the antenna and substrate, the substrate FR4 is applied within $Ù_r$ < 1. In the Fig 4 it has good return loss at it tends to near centre frequency. In Fig 5 VSWR has more slanted towards the frequency, it has 2.68 GHz at m1 position. In Fig. 7 2D total gain is plotted which at m1 highest gain vale plotted. In Fig 6 the input impedance is plotted using smith chart it gives high impedance at m2 region. In Fig 8 the total radiation pattern is plotted in 3D axis a s maximum radiation propagates in X axis. In fig.9 the mesh analysis is done which gives complete mesh grouping for local SAR analysis.

V. Comparative Results

The comparisons from three different antenna performances are given in Table 2.

Parameter	IFA	PIFA	PIFA L
Centre frequency	2.68GHz	2.68GHz	2.68GHz
MinS11 value	-17.94dB	-20.2dB	-28.0dB
VSWR	1.290	2.500	2.6800
Radiation pattern	Broader	Narrow	Broader

Table 2: Comparative results

VI. Conclusion

The antenna design and analysis performance was simulated in Ansoft HFSS software. Further optimization and analysis can be performed with 4X4 antenna positioning at different location on the substrate which leads to more data rates tends to 4G technology with MIMO. Single meander and double meander structure can be designed along PIFA to get high data rate in mobile handset operating at 698 MHz to 960 MHz [4]. These PIFA antennas are mainly used in Multimedia application for 4G Mobile Phones. The proposed antenna has good radiation patterns and gain at different frequencies. Multiband design can b e done by adding additional radiating branches [6].

References:

[1.] Hottinen, A., O. Tirkkonen, and R. Wichman, Multi-antenna Transceiver Techniques for 3G and Beyond, Wiley, West Sussex, England, 2003.

[2]. Foschini,G.J. and M .J.Gans, "On limits of wireless communications in a fading environment whenusing multiple antennas," Wireless Personal Commun., Vol. 6, 311–335, 1998.

[3] 3GPP TS 36.101, V8.3.0, "EUTRA User Equipment Radio Transmission and Reception," September 2008.

[4] L. Zheng, X. Zhang and S. Lai, "Resonant Characteristics of the Meander-line Dipole Antenna," Journal of Microwaves, vol. 3, 2006.

[5] M. Ali, S. S. Stuchly, and K. Caputa, "A wide-band dual meandersleeveantenna," J. Electromagn. Waves Application., vol. 10, no. 9, pp. 1223– 1236, 1996.

[6] M. Ali, G. J. Hayes, H.-S. Hwang, and R. A. Sadler, "Design of a multiband internal antenna for third generation mobile phone handsets," IEEE Trans. Antennas Propagation., vol. 51, pp. 1452–1461, July 2003

[7] Hien Ba Chu ; Shirai, H. ; Chien Ngoc Dao, "High efficiency small antenna for WLAN application" Publication Year: 2013 , Page(s): 757 – 760