Journal of The Gujarat Research Society
ISSN: 0374-8588
Volume 21 Issue 8, August 2019

A REVIEW PAPER ON MINIATURIZED PLANAR INVERTED-F ANTENNA (PIFA) FOR 5G

Mohamad Umair
Faculty of Engineering and Technology
Jain (Deemed-to-be University), Ramnagar District, Karnataka – 562112
Email Id- b.mohmadumair@jainuniversity.ac.in

Abstract

This paper provides a comprehensive review on the designing of the miniaturized Planar Inverted-F Antenna (PIFA) for 5G communication networks, including Long-Term Evolution (LTE) Advanced mobile communication services. By showing the radiation pattern, voltage standing wave ratio (VSWR) and antenna gain of the designed Planar Inverted-F Antenna (PIFA), this review paper evaluates its performance. To show the key characteristics of the Planar Inverted-F Antenna (PIFA), this paper modelled and simulated it with various variances. Moreover, the real Planar Inverted-F Antenna was fabricated and measurements were done to validate the simulated characteristics of the internal antenna. This paper provides a detailed review on the design and analysis of existing PIFA antennas that have been validated by various researchers during last decade across the globe.

Keywords: *Planar Inverted-F Antenna (PIFA), Long-Term Evolution (LTE), 5G, Mobile communication.*

I. INTRODUCTION

Today, because of the small size of the wireless communication device, the miniaturisation of the antenna is becoming increasingly necessary [1]. As the antenna size is primarily dictated by the wave length, it is difficult for existing mobile communication networks to miniaturise the antenna [2]. The method of using dielectric materials with high permittivity to miniaturise the antenna has been studied by several researchers to address this difficulty [3]. However, because of the decrease in radiation effectiveness and dielectric loss, this process causes a decrease in antenna gain [4]. For this reason, there has been an increase in the need to research antenna miniaturisation by changing the antenna structure, not by using dielectric materials [5].

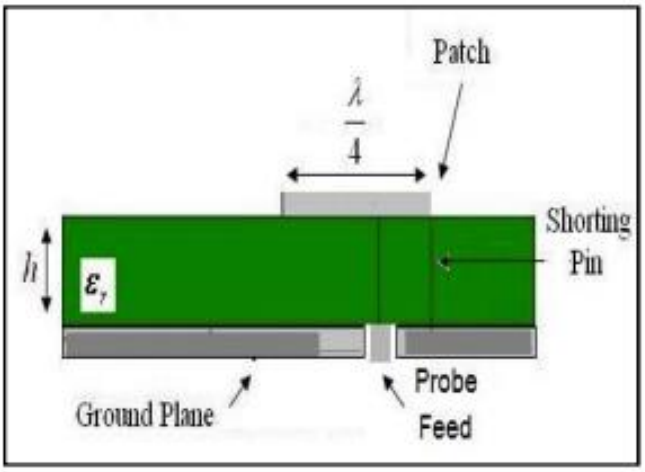

Fig. 1 Shows the Geometry of Planar Inverted F-Antenna

The width W of the DRA antenna can be determined by utilizing the following equation.

$$w = \frac{c}{2\, f_r \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where
f_r denotes the resonant frequency, and
r represents substrate dielectric constant

The effective dielectric constant (ε_{reff}) of DRA antenna is derived by using the following equations.

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2} \sqrt{\left(1 + 12\frac{h}{W}\right)}$$

Where h denotes the height of the antenna and W denotes the width.

The length of the antenna may be measured by applying the following equation.

$$L = \frac{c}{2\, f_r \sqrt{\varepsilon_{reff}}}$$

The antenna length extension is calculated by applying the equation below.

$$\Delta L = 0.412\, h\, \frac{\left(\varepsilon_{reff} + 0.3\right)\left(\frac{W}{h} + 0.246\right)}{\left(\varepsilon_{reff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)}$$

Here W represents the width and h denotes the height.

The real length (L_{eff}) of the antenna can be calculated by using the following formula.

$$L_{eff} = L + 2\Delta L$$

A Planar Inverted-F Antenna (PIFA) is around half the general dipole antenna size and has a ground layer conductor layer in it. The relation between the characteristics of wide band width and material thickness can be calculated by the following equation.

$$BW = \frac{Ah}{\lambda_0\sqrt{\varepsilon_r}} = \sqrt{\frac{W}{L}}$$

For A =180

$$\frac{h}{\lambda_0\sqrt{\varepsilon_r}} \leq 0.045$$

For A = 200

$$0.045 \leq \frac{h}{\lambda_0\sqrt{\varepsilon_r}} \leq 0.075$$

For A =220

$$0.075 \leq \frac{h}{\lambda_0\sqrt{\varepsilon_r}}$$

Where BW is a broad band width, A is the dielectric material area, h is the dielectric material thickness, λ0 is the wavelength, ε_r is the dielectric permittivity, D is the antenna direction, W and L are the radiating element width and length, respectively, in a PIFA [6][7].

II. LITERATURE REVIEW

An analysis on dual-band platform-free PIFA for 5G MIMO mobile device applications was conducted by Liu et al. For the 5G multiple-input multiple-output (MIMO) framework of mobile devices, a dual-band platform-free antenna is proposed. The antenna is created by adding to the planar inverted-F antenna (PIFA) a vertical metallic patch and setting another PIFA through coupling to feed the antenna. The vertical patch will effectively suppress the fringe currents on the ground plane, making the electromagnetic antenna compliant with various working platforms, e.g. the antenna inside the actual system is not influenced by other components, and vice versa [7].

A paper on the configuration of a broadband all-textile slotted PIFA was done by Soh et al. A new PIFA antenna structure based on broadband textiles designed for wireless body area network (WBAN) applications is introduced. It is possible to explicitly incorporate the new topology into clothing. The analysis begins by considering three different materials: lightweight copper foil and conductive textiles made of ShieldIt Super and pure copper polyester taffeta. By implementing a novel and easy slot in the radiating patch, bandwidth broadening is successfully achieved. The calculated coefficient of reflection and characteristics of radiation agree well with simulations [6].

III. DISCUSSION AND CONCLUSION

This paper models, simulates, and tests a portable multi-band internal antenna for mobile handsets which can cover WCDMA800, WCDMA850, GSM900, DCS, PCS, WCDMA2100, LTE2100 communication facilities, 5G communication networks. For a typical application, this multi-band internal antenna demonstrates a satisfying efficiency. Compared to the actual results of the antenna made, the demonstration confirmed the possibility of commercialising PIFA in the proposed manner. In the E-plane radiation pattern, the beam width is around 120°, and at 960 MHz the gain is 5.6 dBi. At the E-plane, radiation patterns from 824 MHz to 2.17 GHz have identical patterns, and as the frequency rises, a side lobe is created at the H-plane. This side lobe, however, is not considered to be a major problem since the main beam, which is vertical to the antenna side, is comparatively very thin.

IV. REFERENCES

[1] Q. Bai and R. Langley, “Crumpling of PIFA textile antenna,” *IEEE Trans. Antennas Propag.*, 2012, doi: 10.1109/TAP.2011.2167944.

[2] M. C. Huynh and W. Stutzman, “Ground plane effects on planar inverted-F antenna (PIFA) performance,” 2003, doi: 10.1049/ip-map:20030551.

[3] Sanjeev Kumar, “Triple Frequency S-Shaped Circularly Polarized Microstrip Antenna with Small Frequency-Ratio,” *Int. J. Innov. Res. Comput. Commun. Eng.*, vol. 4, no. 8, 2016.
[Online]. Available: http://www.ijircce.com/upload/2016/august/24_Triple_new.pdf.

[4] H. T. Chattha, Y. Huang, M. K. Ishfaq, and S. J. Boyes, “A Comprehensive Parametric Study of Planar Inverted-F Antenna,” *Wirel. Eng. Technol.*, 2012, doi: 10.4236/wet.2012.31001.

[5] M. Komulainen, M. Berg, H. Jantunen, E. T. Salonen, and C. Free, “A frequency tuning method for a planar inverted-F antenna,” *IEEE Trans. Antennas Propag.*, 2008, doi: 10.1109/TAP.2008.919200.

[6] P. J. Soh, G. A. E. Vandenbosch, S. L. Ooi, and N. H. M. Rais, “Design of a broadband all-textile slotted PIFA,” *IEEE Trans. Antennas Propag.*, 2012, doi: 10.1109/TAP.2011.2167950.

[7] D. Q. Liu, M. Zhang, H. J. Luo, H. L. Wen, and J. Wang, “Dual-band platform-free PIFA for 5G MIMO application of mobile devices,” *IEEE Trans. Antennas Propag.*, 2018, doi: 10.1109/TAP.2018.2863109.