PIFA Antenna Design for 5G Wireless Application

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Abstract. A New Microstrip PIFA antenna is proposed for wireless applications. The proposed antenna structure is consisting of microstrip antenna with T shaped slots on the patch and two parallel slots in the ground for bandwidth enhancement. This antenna has been design based on a FR-4. The PIFA antenna design have two an operating frequency of 2.34 GHz and 25.4 GHz with S11 -25 and -15.2 dB, while peak gain is about 2.82 dB, 9.654 dB and directivity is 3.122 dB, 9.776 dB over the operating frequency, respectively. Therefore, it suitable for applications of wireless communication with good matching and return loss characteristics. The proposed design model and performance evaluation of PIFA antenna has been executed by CST Microwave Studio.

Keyword: PIFA antenna, wireless application.

Introduction .I

the huge production of cell phones has developed rapidly, frequency bands have been generated and the market needs miniature mobile phones with additional facilities that offer the consumer the opportunity to function with optimum performance. In addition, because of antenna radiation, it is important to the the hazards that affect the human body. Antenna In the past the cell phone was very weighty, and had an external antenna on the highest telephone that was not very strong at the head of the human being, and much of the radiate signal was mirrored and absorbed by the head of the human being[1]

Thanks to its advantages such as SAR speed and lower interactions with the handheld environments, PIFA antennas are commonly used in the design of cell phone antennas, but one of the key problems is the limited bandwidth of PIFA antennas. A solution to this problem may be wideband and multiband PIFA antenna[2]. Via the configuration of antenna or broadband

There have recently been several types of internal antennas, such as a PIFA antenna, a fractal antenna and a monopoly antenna [3]. These antennas can cover a single, dual band, broadband and multi-band antenna configuration. I

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PIF is the pest antenna architecture Due to it is multiband functionality and compact dimensions ,..P IFA Gallery contains It was created by the Inverted-F (IFA) antenna as the union suffers Narrow bandwidth, over which the radiator of the wire has been

replaced Short plane at IFA. PIFA has primarily improved its excellent compact size efficiency [6,7,8].A rising demand is drawing to thresholds for mobile data.

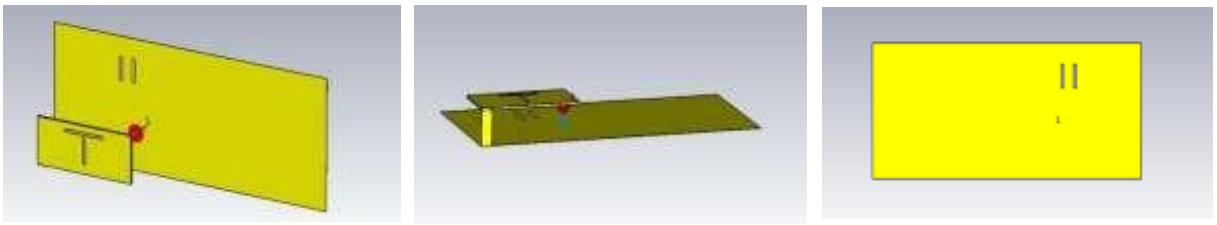
In 2016 Surender Rana, Abhishek Thakur, Hardeep Singh Saini,Rajesh Kumar they designed Inverted F Antenna (PIFA) for the handheld and wireless device Communication the a low profile and a wide track devices are offered. The antenna appears widely Frequency range from 1.35 GHz to 2.51 GHz with improvement Impedance matching covers GPS, DCS, computers, 3G, 4G, and WLAN / Bluetooth bands with VSWR 2. Size of the upper correction tool [9]

2016, S. Jeevagan et al [10]. Proposed an antenna backed with bow-tie shaped slot. The proposed design is fabricated on Rogers RT Duroid 5880. The first and second resonances are at 9.98 GHz and 10.6 GHz respectively. The bandwidth of the proposed antenna is 1.03 GHz (9.43%) and gain of 3.7 dBi.

In this paper, we proposed a new microstrip PIFA antenna with T- slot shape on the patch that used in wireless application.

Planar Inverted F ANTENNA DESIGN

The configuration of a proposed PIFA antenna has shown in Fig 1 **a**. The proposed antenna is feeding via an axial probe feed is given between the ground plane and patch element. The PIFA system antenna consists of a ground surface, a radiation patch over the surface and the plane with a short. The surface of the upper irradiation correction tool is folded at one end of the correction tool and the grounding plate is grounded to reduce the antenna length as shown in Fig 1 b and c.



(a) (b) (c)

Fig (1) PIFA antenna **a:** top view **b**: side view (shows antenna feeding location and type) **c:** Bottom view (illustrate the location and shape of the slot at the ground)

The correction size and resonant frequency can be determined by the following equations:

$$L_p + W_p - W = \frac{\lambda}{4} \quad (1)$$

$$F_r \times \lambda = \frac{C}{\sqrt{\varepsilon_r}} \quad (2)$$

$$F_r = \frac{c}{4(L_p + w_p w)\sqrt{\varepsilon_r}} \quad (3)$$

Where L_P is correction length, W_P is correction width, C is light speed, ε_r is dielectric constant and, $\boldsymbol{\lambda}$ is wavelength. For the nature of the proposed PIFA antenna which is

dielectric constant (aller = 4.3) and thickness (h = 0.035 mm), FR4 Epoxy substrate material is used. The T-shaped top radiator patch that boosts the current distribution and antenna parameters. The plate shortens the floor plane and shortens the radiation layer. Table 1 lists the precise dimensions of the proposed PIFA antenna.

Table 1 dimension of PIFA antenna

Parameter	Optimized Value (mm)
Ws substrate Width	54
Ls substrate length	65
H substrate thickness	0.035
Wp patch Width	49
Lp patch length	55
T patch thickness	0.035
Wg Ground Width	60
Lg Ground length	93
L short	4.105
tg Ground thickness	0.035
W short	13
Wslot1	1
Lslot1	45

The measurements of the ground plane are 93 mm Lg and 45 mm Wg and the thickness 0.035 mm. The top parchment thickness is Lp 37.5 mm, Wp 16.5 mm. The two spaces are the same on the ground floor. Two equivalent slots have 8 mm x 1 mm as shown in the figure. (c) 1(1). The ground plane of the antenna is adjusted with the addition of two open-ended slots in order to boost PIFA antenna efficiency parameters primarily for isolation. Consequently, the rectangular slots in the soil control the present division. The slots are designed so that the isolation between antenna elements is below an appropriate -15 dB level. In the ground plane, the slots are positioned at the plane's edge so that they don't affect the radiation patch's resonance behavior.

Results and discussion

For the PIFA antenna design, the reflection coefficients are illustrated in Fig(2).The reflection coefficients indicates that the proposed PIFA antenna resonates at 2.34 GHz and 25.4 GHz with S11 -25 and -15.2 dB respectively.

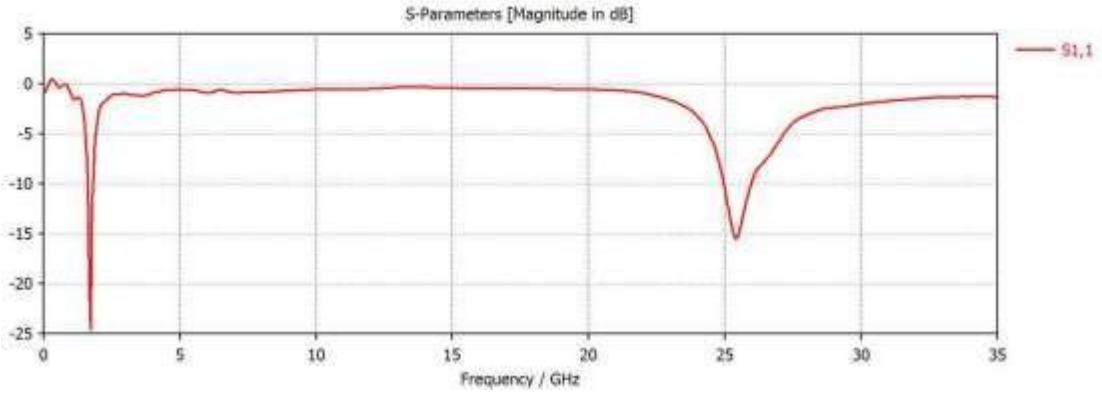
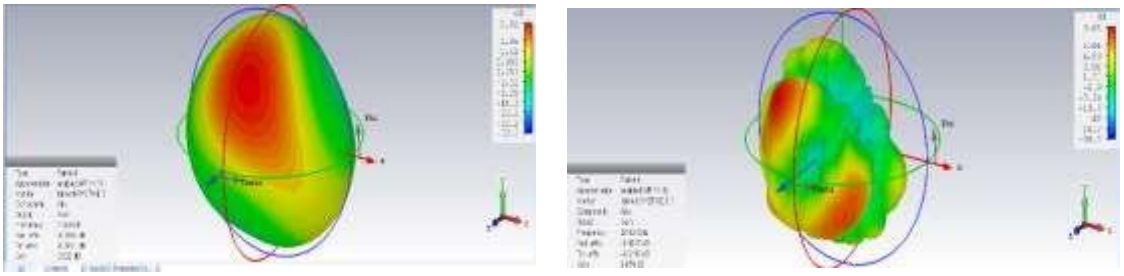


Figure 2 S11 parameter of PIFA antenna

While, The 3D gain and Directivity of the PIFA antenna are shown in Fig (3 and 4). Where, the maximum value of the gain is 2.82 dB, 9.654 dB and directivity is 3.122



dB, 9.776 dB

Figure(3) 3D Gain of PIFA

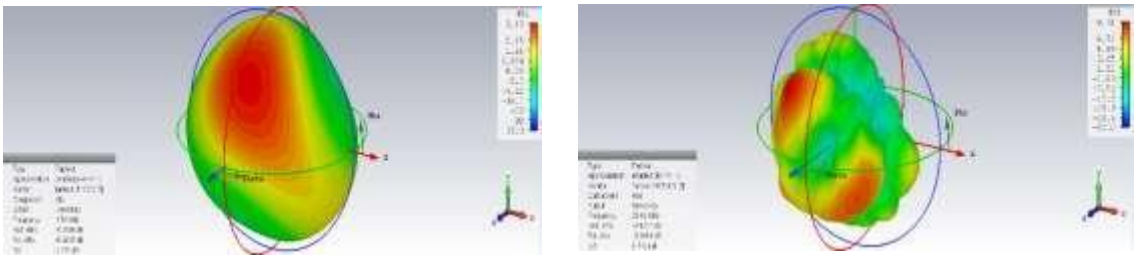
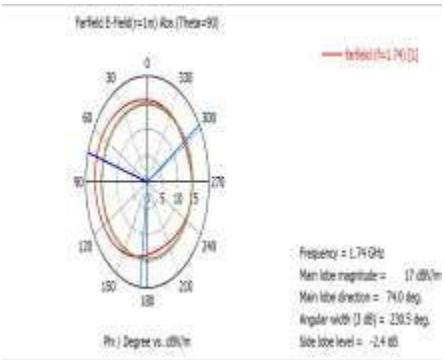
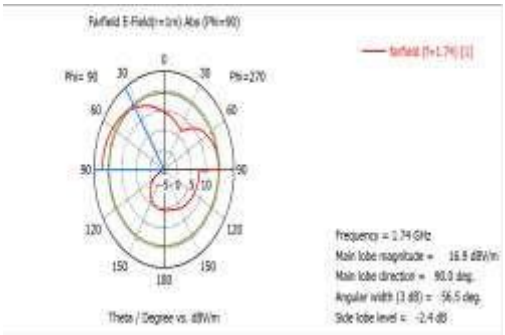


Fig (4) Directivity of PIFA

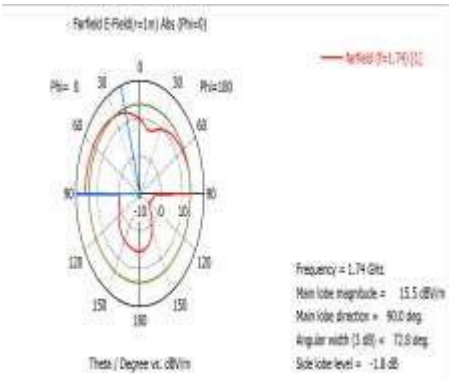
. The radiation patterns for the T-slot is shown in Figure 5 Resonant frequency of the T-slot design is 1.7GHz, in the x-y plane ($\theta = 90^o$); the value of main lobe magnitude is (17) dB; the main lobe direction is (74.0^o) and the angular width is (230.5^o). While in the y-z plane ($\varphi = 90^o$ represent E-plane), the main lobe magnitude is (16.9) dB, the main lobe direction is (90.0^o) and the angular width is (56.5^o), but the x-z plane ($\varphi = 0^o$ represent H-plane) the main
lobe magnitude is (15.5) dB; the main lobe direction is (90.0^o) and the angular width is (72.8^o).



X-Y

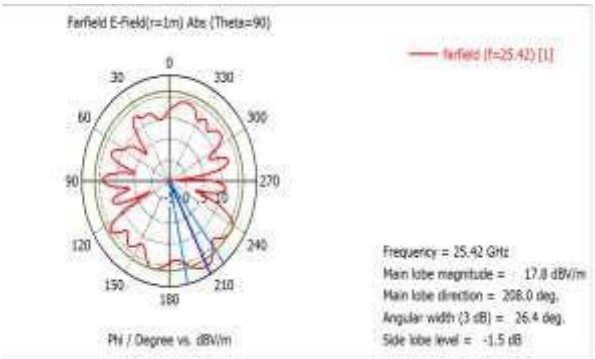


Y-Z

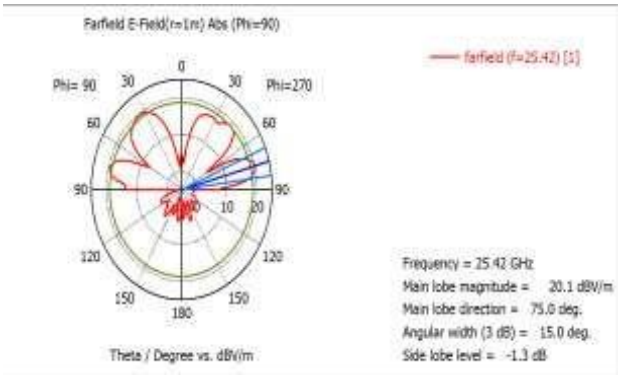


X-Z

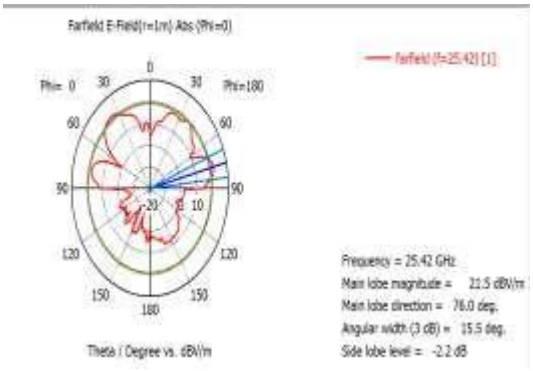
Figure 5 Radiation pattern of the PIFA at f=1.74 GHz



X-Y



Y-Z



X-Z

Figure 6 Radiation pattern of the PIFA at f=GHz

This is for the first frequency (the first band), but for the second frequency (the second band), we will show its data.For the second package of frequency 25.4GHz,. The radiation patterns for the T-slot is shown in Figure 6. Resonant frequency of the T-slot design is 25.4GHz, in the x-y plane ($\theta = 90^o$); the value of main lobe magnitude is (17.8) dB; the main lobe direction is (208.0^o) and the angular width is (26.4^o). While in the y-z plane ($\varphi = 90^o$ represent E-plane), the main lobe magnitude is (20.1) dB, the main lobe direction is (75.0^o) and the angular width is (15.0^o), but the x-z plane ($\varphi = 0^o$ represent H-plane) the main lobe magnitude is (21.0) dB; the main lobe direction is (76.0^o) and the angular width is (15.5^o).

Conclusion

A new design for future 5 G communication devices, Planar Inverted F Antenna, was suggested in this report. Thanks to its compact size and low height, the built antenna can be incorporated into any wireless system. The antenna is designed to display good .radiation patterns and high efficiency

References

[1] Nazem A., and Khalid S., "Mobile Phone Antenna Design", Master Thesis, Department of Applied Signal Processing, Blekinge Institute of Technology 37179 Karlskrona, Sweden, 2015

[2] Constantine A. Balanis, "Antenna Theory Analysis and Design", *"Modern antenna hand book, Published by John Wiley & Sons, Inc., Hoboken, New Jersey,2016.*

[3] Saad Wasmi L., Kaydar M. Q. and Bareq M. A., "Design and Simulation Dual-Band PIFA Antenna for GSM Systems", 9th International Multi Conference on Systems, 2012.

[4] Chenhui J.,"Microwave and Millimeter-Wave Integrated Circuit Systems in Packaging", Ph.D Thesis, Technical University of Denmark, 2010.

[5] Adnan I., and Muhammad Nadeem R., "A Dual band balanced planar inverted F antenna (PIFA) for mobile applications" IEEE Proc-Microwave, Antennas Propagation, Vol. 149, No, 2, pp. 85-91,2013.

[6] El Nabaoui D., Tajmouati A., Zbitou J., Errkik A., Elabdellaoui L., and Mediavilla A., "A New Design of a Low-Cost Multiband Fractal CPW-Fed Antenna", International Journal of Microwave and Optical Technology (IJMOT), Vol. 13, No. 1, PP. 1-7, January 2018.

[7] David M. Pozar, "Microwave Engineering" 4th Edition, Wiley, 2011.

[8] Nepa P., Manara G., Serra A.A., and Nenna g.,"Multiband PIFA for WLAN mobile terminals", IEEE Antennas Wireless Propagat Letters, Vol. 4, pp. 349 – 350,2005.

[9] Mahatthanajatuphat C., Saleekaw S., Akkaraekthalin P. and Krairiksh M., "A Rhombic patch monopole Antenna with ModifiedMinkowski Fractal Geometry for UMTS, WLAN, and Mobile WIMAX Application", Progress in Electromagnetics Research, PIER Vol. 89, pp. 57--74, 2009.

[10] Jeevagan G., navukarasu L., Ganesh babu.T., and Rajkumar.R, R..A., "Design of an E Shaped Patch Antenna for GPS and IRNSS Application", IEEE International Conference on Advanced Communication Control and Computing Technologies (ICACCCT) , pp. 179-183, 2016.