Design of Planer Inverted F Antennas (PIFA): A Review

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Abstract—In this paper exploring the various PIFA (planarinverted F antenna) antenna and their performance improvement technique and enable then for wireless communication. In wireless communication a low profile antenna that support multiband and wideband operation [1]-[2] is required .In order to meet these requirement PIFA designs are needed. PIFA antennas are compact (compress size) and support multiband and wideband operations. Because of such antennas are suitable for the devices where space is a major issue. PIFA antenna has low backward radiation and hence it minimizes electromagnetic wave absorption. PIFA has a self resonating structure. Height of radiator and variation of distance , location and length affect the performance of the antenna .Therefore PIFA can be used for variety of application such as in mobile and radio communication because of its compact size, reduced length and easy integration. It [6] representation, measurement and calculation for this antenna have been done with the help of software CST microwave studio.

Keyword—PIFA antenna, tuned internal antenna, dual-band PIFA, novel multiband PIFA, CST microwave studio.

I. INTRODUCTION

THE modern wireless communication devices are reducing in size and are required to operate at multiple frequency band in order to provide enhanced and multifunctional performance. Multiband antennas are required for communication devices to support multiple standards. Due to the device convergence style in the mobile handset, very limited space is available for the antenna structure. The PIFA antenna is small in size and easy to manufacture and has low fabrication cost .PIFA has an omni-directional pattern and provides high gain in vertical and horizontal direction. The structure of PIFA is simple and easily hidden in handset when compared to other conventional antenna.

PIFA is type of inverted F antenna (IFA) in which a wire radiation is substituted by a plate to increase the bandwidth. The antenna not only shows improved performance but also reduce backward radiation toward user's body and head i.e. it Minimizes SAR (Specific Absorption Rate)[3] .In discuss about different methods are used for reduce the size and cost of antenna in conjunction with its increasing service provided by the antenna and vast range of application uses PIFA as their basic antenna covering wide frequency band of GSM (Global System for Mobile Communications, 880-980 MHz), DCS(Digital Communication System, 1710MHz – 1880MHz), PCS (Personal Communication Services, 1880-1990 MHz), Bluetooth (2400-2480MHz), UMTS (Universal Mobile Telecommunications System, 1.9-2.17 GHz), WiBro (2300-2390 MHz), WLAN (wireless Local Area Network, 5.2GHz - 5.8GHz), ISM (Industrial, scientific and medical, 2.40-2.48GHz) and 3G, 4G LTE.

II.Various Design OF PIFA Antenna

1. A simple PIFA-Based tuned internal antenna for personal communication handset.

In this paper [Viet-Anh Nguyen, Rashid-Ahmad Bhatti, and Seong-Ook Park,2008], [1]for tuning over wideband used a varactor diode i.e. typical varactor diode package of MA46H series is integrated in this antenna structure is shown in fig(a). Due to this technique frequency promising for designing antenna tunable over wide range due to their very good dc voltage controlled reactance .PIFA is active antenna and it can overcome limitation of large size and low fabrication cost therefore tunable multiband antenna are becoming more demanding for use in multifunctional handset due to their significant advantage in term of weight, volume and performance.

In tunable antenna slots are created in structure of excite multiple resonance frequency in the antenna. This antenna generated three frequency $\mathcal{F}1 = 2GHz$ is first resonance frequency and$\mathcal{F}2 = 5.35GHz$ is second resonance frequency $\mathcal{F}3 = 5.8GHz$ third resonance frequency therefore each PIFA-patch element will be designed by based on approximated equation is

$$(l + w) = \frac{\lambda}{4(\sqrt{\varepsilon r})}$$

Where-
$\lambda$is resonance wavelength at desired band
$l$and$w$ are length and width of the radiating element
$\varepsilon r$is dielectric constant of the substrate.
To reduce the total volume of the antenna with tunable at and near $\mathcal{F}1$,propose to attach a varactor diode to the antenna in electrically tunning tunable location of one slot which relate to $\mathcal{F}1$,by changing the varactor capacitance, it will affect to change length and width of slot .Then overall size the tunable antenna is 19.5mmx9.8mmx4mm (0.741 cm3) .And this size is suitable for 4G handset .This

antenna also suitable for multifunctional mobile phone because it will covers DCS, PCS, UMTS, Bluetooth, WiBro, WLAN and ISM band at different dc bias level and return loss of the antenna at different frequency bands are within acceptable limits with reasonable radiation performance.

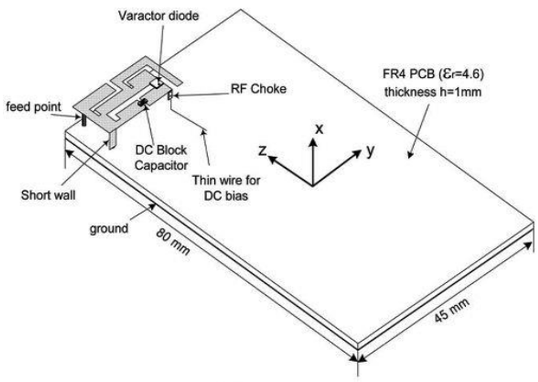

Fig. (a) simple PIFA-Based tunable internal antenna of 3-D view.

2. Design Novel Multiband PIFA for mobile terminals.

In this paper [Rashid Ahmad Bhatti, Young Sin Shin, Ngoc-Anh Nguyen, and Seong-Ook Park, 2008][2] the propose for a Novel Multiband PIFA antenna that can support seven frequency bands. Therefore it designed to operate GSM, PCS, UMTS, WiBro, Bluetooth, S-DMB and WLAN frequency bands. Multiple frequency bands realized by using slots and quarter-wavelength resonating strips. A matching stub and multiple short circuiting strips are utilized for improving impedance matching across the targeted frequency band.

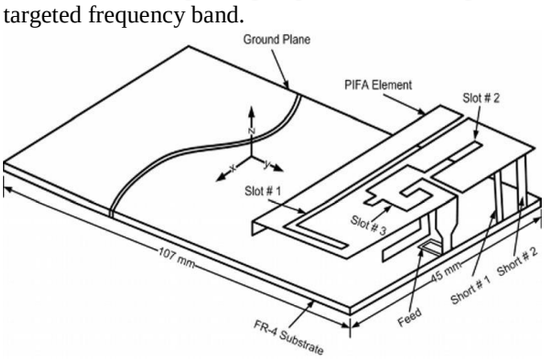

Fig (b). Novel Multiband PIFA of 3-D view.

Geometry of proposed antenna is shown in fig (b). The PIFA antenna is mounted at the top of the ground plane measuring 45 mm x107 mm. And size of the antenna is 21mm x 45 mm x 8 mm. The design of antenna is started with conventional planer inverted F antenna element with single feed and a short circuiting strip. Then first created L-shaped long slot (slot#1) to make the antenna resonant at 0.9 GHz and 1.85 GHz. Second created L-shaped long slot (slot#2) to get an additional resonance at 3.7 GHz , last third created slot (slot#3) is at the center of the patch and joined to the slot#2 for getting an resonance at 2.8 GHz.

Antenna characterized by measuring its return loss and radiation performance. By using Network Analyzer measured return loss, it better than -6dB across all the targeted frequency bands. It shows Omni-directional radiation performance is achieved at the GSM band and Quasi Omni-direction radiation performance is achieved at other frequency band.

3.A Dual-Band U-slot PIFA antenna with ground slit for RFID application.

In this paper [D. K. Naji, Abdul-Kareem A. A Mohammed, 2013][3] PIFA with U-slot (U-PIFA) and slit in ground are represented. Proposed PIFA is compact with single coaxial feed, single short strip, and single short pin. The achievement of this antenna was the design of ISM microwave bands 2.45-5.8 GHz dual band PIFA antenna by using slit in ground to control the selection of lower resonance frequency without any manual effect on the upper resonance frequency which determined from U-slot in the patch and U-PIFA is analyzed by a CST microwave studio .To represent dual band U-slot PIFA by etching U-slot in the rectangular patch printed on a thin dielectric substrate excited by coaxial probe-feed. The U-slot was introduced to independently control the upper resonance frequency where as the slit in ground was introduced to independently control the lower resonance frequency .Input impedance bandwidth of(2.340 to 2.546) GHz and (5.644 to 6.037) GHz for a return loss less than 10 dB have been achieved .

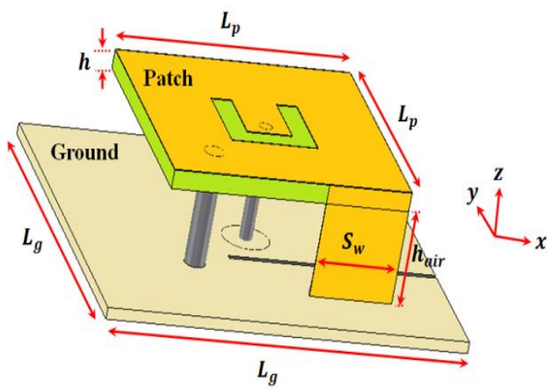

Fig.(c).Geometry of the U-Slot PIFA of 3-D view.

Geometry of the proposed dual band U-PIFA antenna with slit in ground is shown in fig.(c) .The U-PIFA with the total antenna size of 35 mm x 35 mm is printed on an FR4 substrate. To obtain operating frequency 2.45 GHz calculated by the standard design formula for PIFA is

$$FoL = \frac{vo}{4(Lp + Wp)}$$

Where-

- FoL is lower resonance frequency.
- vo is velocity of light.
-Lp and Wp length and width of radiating patch.

The grounded slit-shaped is with the width Wslit and the length Lslit and placed at a distance dslit from the lower side of the ground by introducing the grounded slit-shaped inset into the ground the lower resonance frequency can be tuned easily without any effect on the higher resonance frequency .The result of proposed antenna is operating bandwidth (RL>10 dB) can reach about 206 MHz (2.34-2.54 GHz) or 8.44% centered at 2.45 GHz and 393 MHz (5.64-6.04 GHz) or 6.78% centered at 5.8 GHz which cover the entire ISM RFID band. Gain and efficiency at 2.45 and 5.8 GHz are 2.2 dB and 97% and 6.65 dB and 93% respectively.

4. Bandwidth enhancement for PIFA antenna using circular slot in radiating patch and ground plane for wireless communication.

In this paper [Piyush Kumar Dhurvey1, Prof.Prashant Jain,2015][4] proposed antenna a coaxial feed ,slotted rectangular patch and ground plane. Bandwidth enhancement it can achieved by suitable cutting slots into the rectangular patch and ground plane, because of enhanced bandwidth proposed antenna is suitable for various wireless application .Its represented, and measurement and calculation have been done with the help of software CST microwave studio.

Geometry of the proposed PIFA antenna is shown in fig. (d). This antenna has two layers of copper in between a 6mm thick has been sandwiched .The top layer is a rectangular radiating patch of size 23 mm x 19 mm and bottom layer considered as ground plane, is of the size of 48.5 mm x 19 mm .Which has been made smaller for making space for the other components of the mobile handset .Then proposed PIFA size is 48.5 mm x 19 mm x 6.5 mm

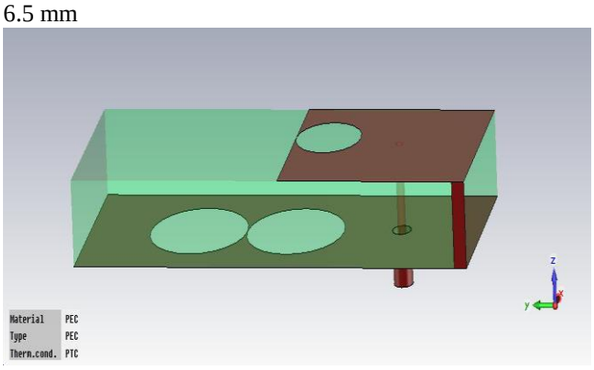

Fig.(d). Geometry of the proposed PIFA of 3-D view

Bandwidth should be centered at a frequency of 2.45 GHz which is calculated by equation,

$$fc = \frac{c}{3Rw + 5.6RL + 3.7h - 3Wf - 3.7Ww - 4.3\square\square fw2 + fl2}$$

Where- Wf is feed width 1 mm.

c is velocity of light.

III. CONCLUSION

PIFA antenna have the attractive features like small size ,light weight and low profile and low fabrication cost .The major limitation of PIFA are narrow bandwidth and low gain .In this paper made the review of various design technique for performance improvement to overcome their limitation.

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