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Parameter Study of a Multiband Tunable PIFA

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***Abstract*— Rapid progress of the wireless communication introduced multi functional telecommunication products . Mobile phone has the prime importance ,since it evolved from mere voice communication to a device with data transfer which includes images and video, along with different internet services . The voice communication itself includes multiple standards . So the devices needs multiple radio elements . Integration of multiple radio elements into a single piece requires tunability. The mobile phones antennas are internal , most popularly Planar Inverted F Antenna is used. The antenna performance is enhanced by tunability over multiple bands**

Keywords*— Pifa, varactor tuning , mobile phones, multiband, parameter study

I. INTRODUCTION

Planar Inverted F antennas(PIFA) is one of the most promising and suitable antenna emerged in the low profile category .PIFA has been used in the wide range of applications such as RFID, UWB and MIMO systems with smart antennas covering wide band of GSM 850 (824-890MHz) ,GSM 900 (890-960MHz), DCS/GSM1800(1710-1880MHz), PCS/GSM 1900(1.850-1990MHz), WiBro (2.3-2.4 GHz), Bluetooth (2.4- 2.48 GHz), DVB-H (UHF: 470–862 MHz; L: 1452–1492 MHz), 802.11 (2.4-2.485 GHz), WLAN (5.16 - 5.5 GHz) and UMTS(2.1 GHz), 4G LTE(700 MHz-3.8GHZ [1]

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II. EVOLUTION OF PIFA

PIFA has been evolved from Inverted L antenna(ILA) . With the introduction of ILA external monopole antennas have been replaced. ILA has a very simple structure. The input impedance also have a similarity with monopole antenna, input impedance have low resistance and high reactance. Inverted L section makes the tunability more easily.

To have better results an antenna needs nearly resistive load to have reduced mismatch loss. Inverted F Antennas (IFA) can perform the requirement .IFA has second inverted L segment at the end of ILA structure. The Inverted L segment is used for the tuning of ILA.IFA has improved matching properties over ILA. Both antennas have narrow bandwidths [2] .So in order to enhance bandwidth, the horizontal element of ILA has been transformed from a wire to a plate . This novel antenna structure is called as Planar Inverted F Antenna (PIFA). PIFA has a self resonating structure [3]

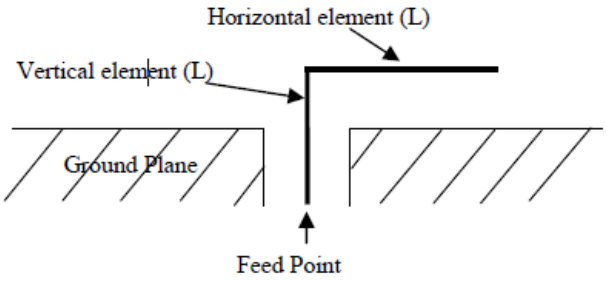

Fig 1. Typical Inverted L Antenna (ILA) structure [2]

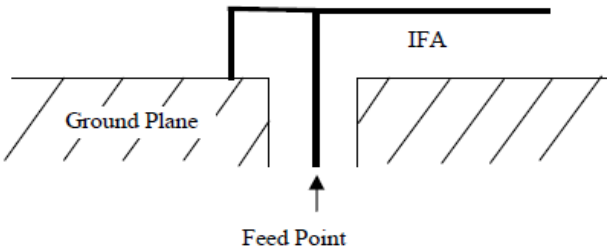

Fig 2.Typical Inverted F antenna(IFA) structure [2]

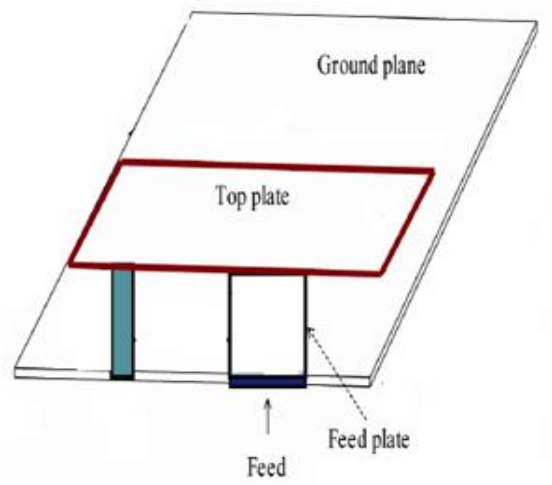

Fig. 3. Typical Planar Inverted-F (PIFA) Antenna Structure [4]

PIFA is the most commonly used internal antenna in commercial wireless applications .Due to the resemblance with short circuit micro strip antenna , PIFA is also known as short circuited micro strip antenna . The shorting pin used near the feed strip in the PIFA structure is a good technique to reduce antenna size [5].But these structure results in narrow impedance bandwidth .These feature of PIFA makes it incompatible for wireless mobile devices [6]

PIFA is commonly used because of the features like small size and light weight. It has good operating bandwidth ad high efficiency. Another important feature of PIFA is that multiband PIFA and single band PIFA has almost same feature. PIFA has dual polarization signal characteristics, which is an important requirement for mobile transceivers .A dual polarization device can receive signal in any orientation. Power requirement of PIFA is less.

The challenges of PIFA are narrow bandwidth , moderate gain and the feeds also contributes spurious radiations.

The resonant frequency [7] of PIFA can be approximated with following expressions: Where W_p and L_p are width and length of radiating patch , h is the height between ground plane and PIFA and W is the shorting pin width .

$$Lp + Wp = \lambda/4 \quad (1)$$

When W/Lp=1 then $Lp + h = \lambda/4$ (2)

When W=0 then $Lp + Wp + h = \lambda/4$ (3)

This paper presents a comprehensive experimental investigation on a multiband PIFA with that includes all the parameters that may affect its resonant frequency . Tunability of PIFA is achieved by means of varactor diode . The effects on the resonant frequency PIFA due to changes in the dimensions of ground plane, the patch length , patch width, and height of the top radiating plate, and the width of the shorting plate from the edge of top plate are presented.

III. ANTENNA STRUCTURE

The configuration of antenna used for this study is shown in figure (4).The radiating element is a reclangular patch with a rectangular slot . The patch size is 40 X 15, The varactor is mounted on this slot which is used for the tuning of the proposed antenna . Radiating patch is placed at a height of 6.2mm above the ground plane . ground plane is mounted on the backside of the lower FR4 plane .Toshiba ISV245 varactor diode is used for tuning since it provides a wide range of tuning .Slot is of dimension 25 X 15 and the open end of slot is shrunk to 1mm.A break is being provide between
Shorting pin and biasing circuit ,to accomadate isolating capacitance C2 ,(.01).The isolating capacitor is used for the biasing of varactor standard 50 Ω coaxial connector is used as the feeding system In order to apply DC bias current to varactor diode, a RF choke resistor was inserted between
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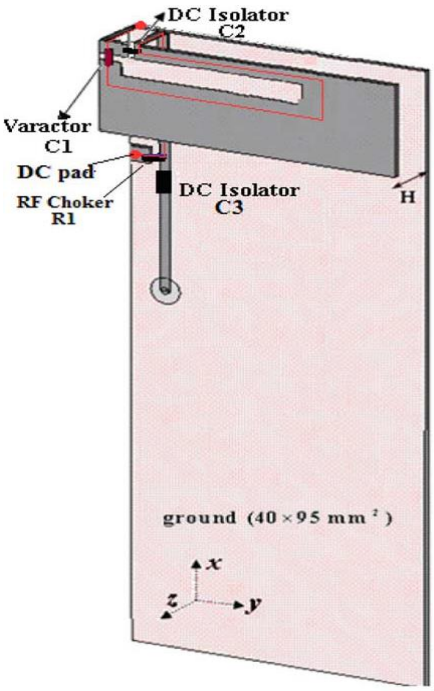
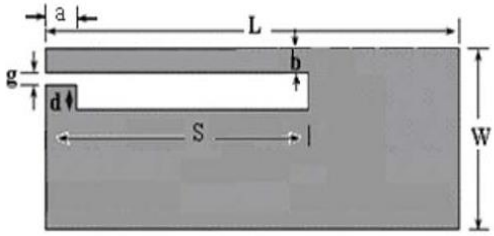


Fig .4. The configuration of PIFA under study



Parameters	Value(mm)
L	40
W	15
H	7
S	25
b	2
d	2
a	3
g	1

Fig 5.Parameters of radiating patch

DC pad and transmission line. A DC isolator of 2.2 nF is also placed on transmission line for the same purpose.The antenna ia printed on FR4 material

IV. EXPERIMENTAL STUDY

The procedure adopted for this study is that only one parameter is changed at a time, and all others parameters are kept constant to observe its effects on the PIFA characteristics. Different set of parameters are considered to cover wide range of values .The operational frequency are changed from 0 to 3 MHz to cover the bands under consideration .The factors included in the study are varactor capacitance, dimensions of ground , dimensions of patch , shorting pin width , radiating patch permittivity , height of patch substrate and feed length .

A. Varactor Capacitance

The simulations are done by varying varactor capacitance from .05 to 5pF. From the continuous analysis, both the resonant frequencies reduces initially and then increases over the range of 0.7 to 1.5pF. From 2pF onwards the resonant frequency reduces. The irregularity in the middle range may be due to presence of slot in the radiating patch .Simulated results are shown in Fig 6

B. Dimensions of ground plane

The width and length of ground plane are varied. Ground width Wg is varied from 30mm to 80mm .Length of ground , Lg varies from 40 to 140.The figures 7 and figure 8 shows the effects of length and width on resonant frequency .With the increase in the ground width , both the resonant frequencies reaches to peak values and then reduces and remain constant.The highest resonant frequency is Occurred when both radiating patch and ground plane has the same width The resonance frequency increases with increase in ground length . Later the frequency reaches a steady state.

C. Dimensions of patch

In case of dimensions of patch , width of the patch and height of the patch are considered for the analysis .The height of the patch varied from 1mm to 4mm . From the results it is seen that , the resonant frequencies decreases with the increase in patch height . As the height increases , wavelength increases hence the resonant frequency gets decreasing.The patch width is being increased from 5mm to 45mm. Upper and lower resonance have different effects with the changes inpatch width . The upper resonance increases with the increase in patch width . But the lower resonance decreases with the increase in patch width .These reesults are shown by fig 9 nd fig 10 .

D.Patch Dielectric

The patch dielectric varied from materials of different relative permitivities from 2.75to 12.94. The frequency decreases with the increase in the permittivity.

E.Shorting pin width

Shorting pin width is varied from 1mm to 10mm . The frequency has a slight increase with increase in the shorting pin width. But as the width increases the lower resonance is not available . It may be due to the intersection occurs between feed line and shorting pin when the shorting pin width is increased .

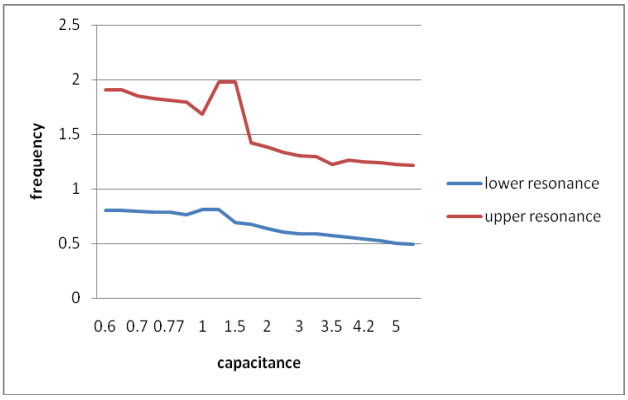


Fig 6.Frequency Vs Capacitance

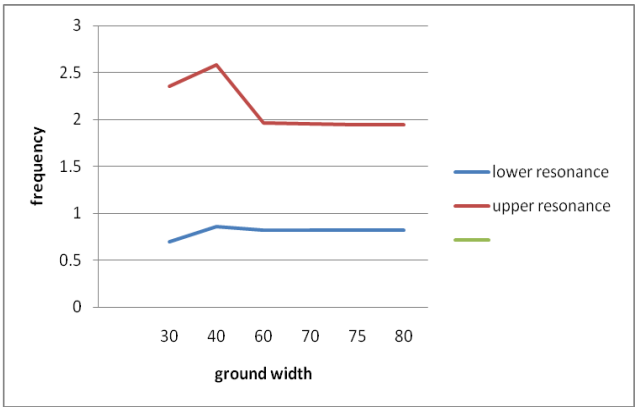


Fig 7.Frequency Vs Ground width

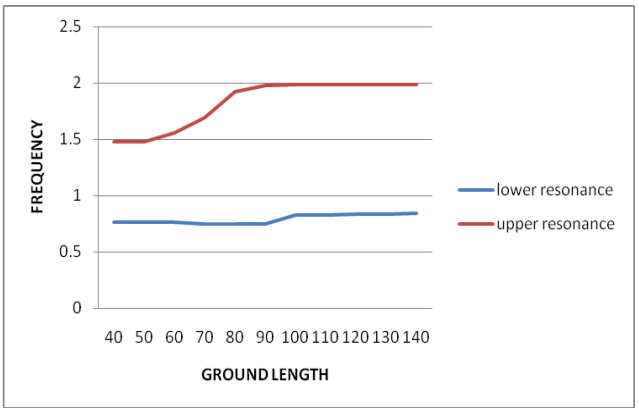


Fig 8.Frequency Vs Ground length

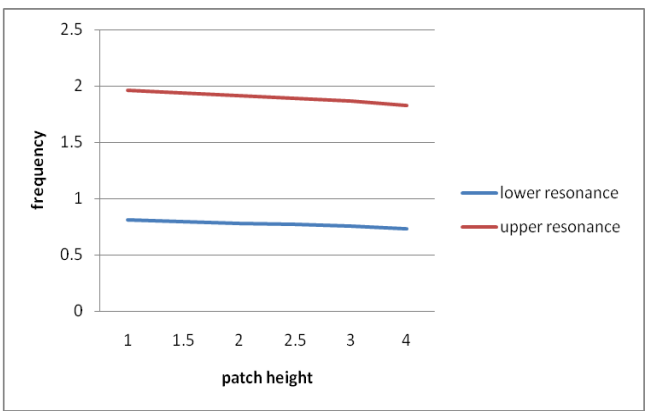


Fig 9.Frequency Vs Patch height

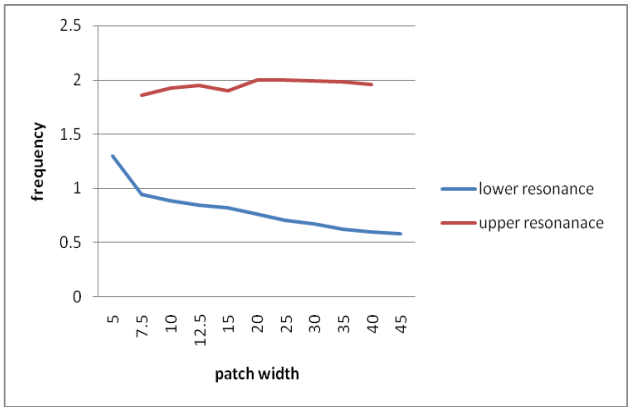


Fig 10.Frequency Vs Patch width

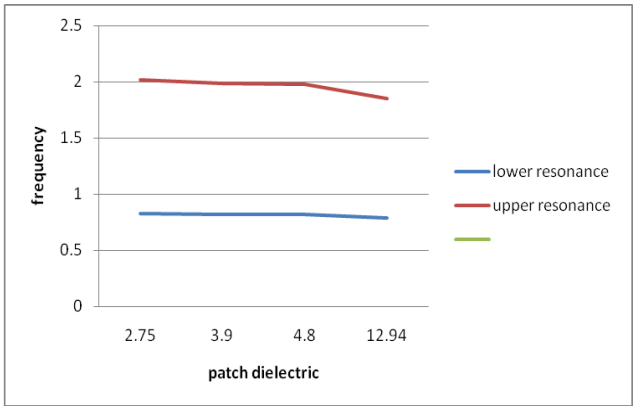


Fig11.Frequency Vs Patch dieelctric

V. CONCLUSIONS

The study shows that PIFA resonance are affected by numberof parameters .The conclusions are summarized as follows

1. Resonant frequency reduces with the increase in the varactor capacitance .
2. High resonant frequencies are obtained when both radiating patch and ground plane have the same width
3. Resonance frequency increases with increase in ground length
4. The resonant frequencies decreases with the increase in patch height
5. .The resonant frequency decreases with the increase in the permittivity .
6.The resonant frequency increases with the increase in shorting pin width

REFERENCES

[1] Hang Wong, Kwai-Man Luk, Chi Hou Chan, Quan Xue,Kwok Kan So, Hau Wah Lai, "Small antennas in Wireless Communications", Proceedings of the IEEE Journal, Vol. 100, No. 7, Page(s): 2109 – 2121, 2012.

[2] W. Geyi, Q. Rao, S. Ali, and D. Wang, "Handset AntennaDesign: Practice and Theory", Progress in Electromagnetic Research Journal (PIER), Vol. 80, Pages: 123–160, 2008

[3] R. Vaughan, **"**Model and results for single mode PIFA antenna", IEEE Antennas and Propagation Society International Symposium, Vol. 4, Page(s): 4028 – 4031, 2004

[4] Hassan Tariq Chattha, Yi Huang, Muhammad Kamran Ishfaq, Stephen J. Boyes, "A Comprehensive Parametric Study of Planar Inverted-F Antenna", Wireless Engineering and Technology, Vol 3,Page(s): 1-11,2012

[5] Taeho Son, "Feeding point determination for PIFA type mobile phone handset internal antenna", IEEE Antennas and Propagation Society International Symposium, Vol. 1A, Page(s): 475 – 478, 2005

[6] J.A. Ray, S.R.B. Chaudhuri, "A review of PIFA technology", IEEE Indian Antenna week (IAW), Page(s): 1 – 4, 2011

[7] Hassan Tariq Chattha, Yi Huang, Xu Zhu, and Yang Lu, "An empirical equation for predicting the resonant frequency of planar inverted-F antennas", IEEE Antennas and Wireless Propagation Letters, Vol.8, Page(s): 856 – 860, 2009