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Bandwidth Enhancement in Dual Band PIFA by Parasitic Element

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ABSTRACT—A design of Dual band PIFA (Planar inverted folded Antenna) for wireless communication system. A PIFA antenna consists of radiating patch with a hook shaped slot .The antenna is fabricated on FR4 substrate with dielectric constant 4.4 its work on dual antenna like 3.3 GHz for WIMAX and 5.2GHz for WLAN application by adding parasitic element lambda/2 radiator along with patch to enhancement of bandwidth in upper band and measured return loss , gain, current distribution, radiation pattern etc.

KEYWORDS: PIFA, Slot antenna, Parasitic element ,Bandwidth Enhancement

I. INTRODUCTION

With the rising of the wireless mobile communication technology , the long term technologies want a awfully little antenna and in addition wish the requirement the necessity of multiband antenna is increased to avoid exploitation two antennas and to allow video , voice and data information to be transmitted. The advantage of planar inverted -F antenna (PIFA) makes them standard in my application requiring an occasional profile antenna profile antenna[1]. By victimization shorting walls to the patch a wider resistance bandwidth has been achived[2].The foremost goals from the pervious analysis work and Literature connected with the antenna are that concenrated on rising metric and improve the parameters like, Radiation Pattern, Gain, Current Distribution.

The paper is divided as: section two describe basic antenna and sickle shaped structure dimensions and configuration.3rd section describe antenna with lambda/2 parasitic radiator along with patch of experimental results. final and 4th reasons for bandwidth enhancement the conclusion and future work.

II. SINGLE BAND PIFA AND ITS PARAMETRIC STUDY

The flat Inverted-F Antenna (PIFA) is viewed as evolved from a quarter-wavelength monopole antenna and is now wide utilized in mobile and transportable radio applications due to

its several engaging attributes like easy style, light ,weight, lowcost, low-profile, conformal nature and reliable performance [3]. several antenna varieties for transportable applications area

unit extensions of PIFA antenna , which is considered mutually of the strongest candidates for multiple input multiple-output (MIMO) systems [4]. It's well-known that, for a monopole antenna, the de-sired length could be a quarter wavelength as it is resonant during this case. exploitation a similar analogy,the subsequent empirical equation was planned for finding the

resonant frequency of PIFA This chapter covers the designing of PIFA using the transmission line model.

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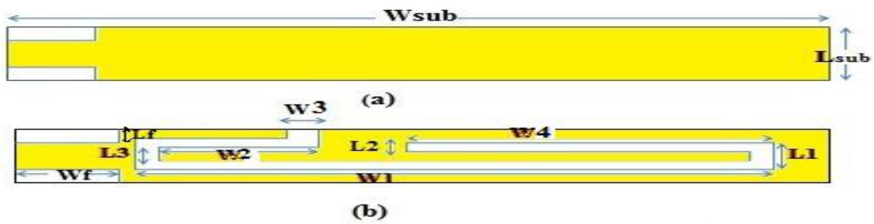

Fig. 1. (a) Baic PIFA (b) Sickle Pattern

Fc = C=4(L +W) (1)

where c is the speed of light/radio wave, L and W are the length and width of the radiating top plate of the PIFA and f0 is the resonant/operating frequency. This equation means that the sum of the length and width of the top plate should be a quarter-wavelength. However, it is actually a very rough approximation and does not cover all the parameters which significantly affect.

The effects on the characteristics of PIFA due to changes in the dimensions of ground plane, the position of PIFA on ground plane, the length, width, and height of the top radiating plate, and the distance of the shorting plate from the edge of top plate are presented. Similarly, the effects of changing the widths of the feed plate and the shorting plate, and the feeding positions.

III. ANTENNA CONFIGURATION

The effect of varying the various parameters of antenna geometry like stub length, dimensions of slot and the effect of the dielectric constant on the designed antenna are analyzed. The radiating top plate has dimensions L , W and the ground plane dimensions are Lg , Wg as shown in Fig;1 The PCB dielectric material used above the rectangular ground plane is FR-4 having a thickness t = 1.6 mm and a relative permittivity Er = 4.4.and loss tangent = 0.02 The space between the ground and the top plate with height h is empty for this investigation although supporting Materials may be used in practice. The feed plate has dimensions Wf * h. The vertical and horizontal distances of the PIFA structure from the ground plane edges are Lz and X espectively, as shown in Fig;1. The ground plane is placed in x-y plane and height of antenna is along z-axis.
The radiating patch is connected to a feed line. The proposed antenna is connected to a 50 ohm SMA connector for signal transmission. The parameters of the proposed antenna are in fig.1 HFSS 2013[4] package is used to obtain the return loss the gain and radiation effenicy and radiation pattern .The simulated return loss shows dual band 3.5 and 5.2 GHz.

Parameters	W_sub	L_sub	h_sub	Wf	Lf	W1	W2	W3
Values(mm)	24	3	1.6	3	2	17	1.6	16
Parameters	L2	W3	L3	W4	L4	W5	L5	W6
Values(mm)	0.5	5.5	0.4	1	0.25	8	1	0.5
Parameters	L6	W7	D	W8	W9	W10	W11	W12
Values(mm)	2	2.6	0.2	1.8	2.6	0.4	13.5	11

Fig. 2. Dimension of Antenna

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IV. PIFA WITH DUAL BAND PROPERTY

In order to understand the phenomena behind this dual band performance , the simulated current distribution for the modified antenna on the radiating stub at 3.5 GHz are presented in fig.1(b)and at 5.2GHz [5].the current concentrated on the edges of the interior and exterior of sickle-shaped slit. Therefore, the antenna impedance changes at high frequency due to the resonant properties of the pair of sickle-shaped structure.

A. For sickle shape (slot in antenna) :

Total length of slot = w1(hal fslot) + w4 + w3 = 12:6 + 5:5 + 1 = 19.2mm
Wavelength of total slot(lambda) / 3 = Total length of slot
Operating Frquency = C/lambda = 3 *10^8=3 *19.2 = 5.2GHz

B. For hook shape

Total length of hook slot = w1 +w3 +w4 = 17+8+5:5 = 30.5 mm
Total Wavelength = 3*30.5
Operating Frequency = 3.27 GHz

V. SIMULATION RESULTS

The measured and simulated return loss characteristics for the proposed antenna are shown in fig.3,.The fabricated antenna has a frequency which covers 3.5 GHz WiMAX, 5.2 GHz
WLAN Application.

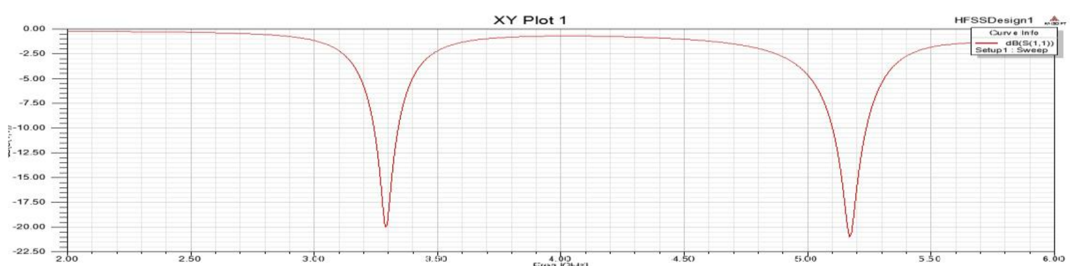

Fig. 3 Return loss of dual band

Fig. 4 Gain of dual band

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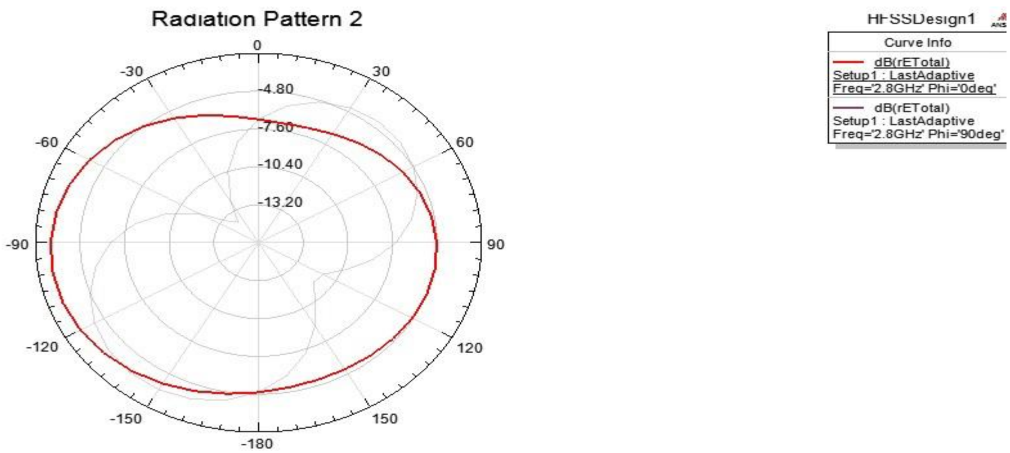

Fig. 5 Radiation pattern of dual band

Current Distributions

As shown in Fig.1(b), by cutting a slit at diverging patch, a brand new resonance in 5.2 GHz for local area network applications may be obtained, and conjointly by changing the falciform slit to the hook-shaped structure another resonance at 3.3 GHz that is appropriate for WiMAX systems
is generated. Finally, it's ascertained that the generation of dual-band performance is sensitive to the cutting a hook shaped slit at the highest layer of antenna configuration[6].

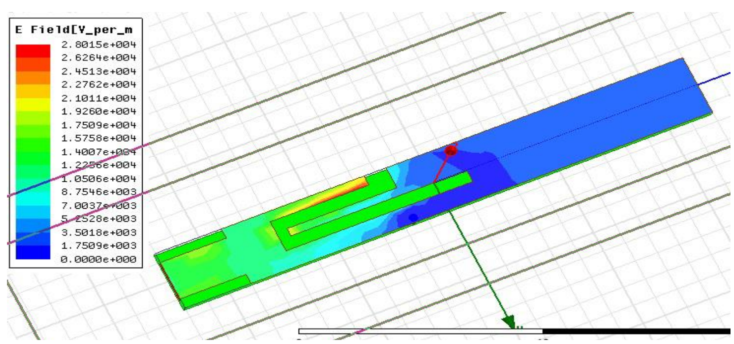

Fig. 6 Simulated surface current distributions at radiating patch, at 5.2 GHz

In order to know the development behind this dual-band performance, the simulated current distributions for the projected antenna on the diverging stub at 3.3 and 5.2 gigacycle per second square measure given in fig.6 It are often as certained in fig.6, at the 5.2 GHz, this targeting the sides of the inside and exterior of the curving slit. Therefore, the antenna ohmic resistance changes at this frequency as a result of the resonant properties of the combine of curving structure [7,8]. fig.7 presents the simulated current distributions of the projected antenna at 3.3 GHz. As shown in fig.7, at the second resonance frequency this flows square measure a lot of dominant around of the highest facet of hook-shaped slit embedded at diverging patch [9].

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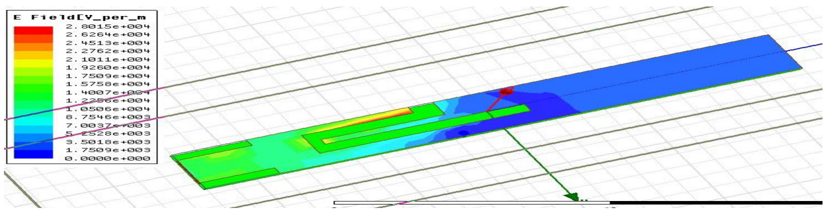

Fig. 7. Simulated surface current distributions at radiating patch, at 3.3 GHz

VI. LIMITATION OF PLANAR INVERTED-F ANTENNA (PIFA)

At present, planar inverted-F antenna (PIFA) is being adopted extensively as telephone set antennas owing to its benefits of compact structure, low profile, straight forward fabrication, low producing value and simple integration with moveable devices. However, a serious disadvantage of the PIFA antenna is its slim ohmic resistance information measure. Hence, it's fascinating to find strategies which will enhance the bandwidths of the PIFA antennas. The information measure of the PIFA antenna is broadened by employing a tapered type divergent patch. Multi-layer patches and a collapsed stub area unit introduced into the interior PIFA to enhance its information measure . The information measure sweetening approaches mentioned higher than each specialize in creating modifications on the radiating parts of PIFA antennas. There
also are alternative bandwidth improvement strategies concentrating on creating modifications on the system ground plane of mobile terminals. Different information measure sweetening techniques going to discuss here uses the parasitic element[10]

VII. DUAL-BAND PIFA WITH PARASITIC ELEMENT

There are many ways to expand PIFA antennas bandwidth, which include using one slit with branches or multiple slits. PIFA variants using those techniques are too many to be enumerated.

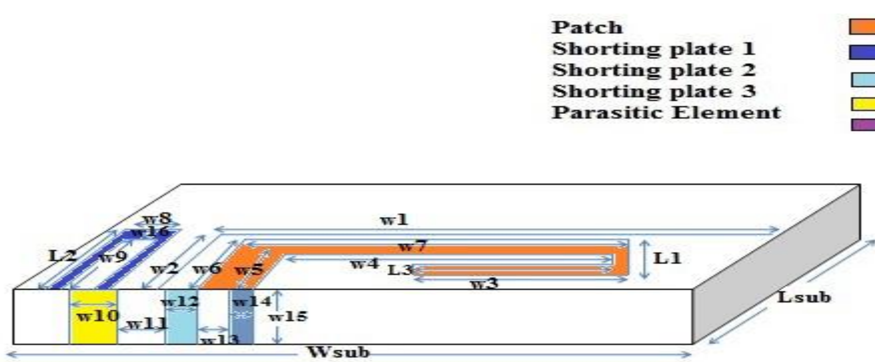

Fig. 8. PIFA with Parasitic Element

Shown in Fig.8 parasitic component. The parasitic component is electrically connected to the bottom through a metal strip. there's no direct association between the most radiator and therefore the parasitic radiator. However, they're electromagnetically coupled.
an additional sweetening within the information measure of PIFA are often achieved by adding rectangular parasitic component as shown in Fig. 8. The approach of adding a parasitic component was employed in the case of wire type antennas, however here it's employed in a flat antenna. Having fastidiously tuned the size, associate optimized style is

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obtained associate inverted-U-shaped parasitic component is extra at a distance Dc= 1mm price from the feed plate in such how that it creates a second resonant frequency at such a worth that the reflection constant S11 remains below -10 db sound unit level. The thicknesses of the parasitic component square measure tc1 wherever tc1=1mm.The Parasitic component is on the patch component for the aim of size reduction, numbers of shorting Plates square measure used for reduced size of antenna and achieving desired radiation diagram. The planned structure operative in twin band at 3.1 GHzper second and 5.2GHz per second frequency information measure. The parasitic component is generally accustomed cowl the best band. As higher frequency suggests that smaller parasitic radiator, this makes antenna style easier. The other reason for exploitation parasitic components at the best band is associate antennas overall performance. With the existence of parasitic component, the potency of the most radiator would possibly degrade from ten percent of a sound unit to a number of sound unit. By assignment the resonance of a parasitic component to the best frequency, the adverse impact on the lower band are often quenched.

ANTENNA DESIGN:

The antenna was fabricated on H = 2.6mm FR4 Epoxy substrate. Dielectric constant Er = 4.4
Tangent Loss = 0.02 Substrate Length = 29.9mm and width = 17.5mm Area30*17.5mm^2 HookSlot
Total slot length = 4.4 + 9.4 +2.7+ 4.3 = 20.8mm
Wavelength at upper frequency = 3*20.8mm Operating Frequency = C/Lambda = 4.48GHz

Parameters	W_sub	L_sub	W1	W2	L1	L2	L3
Values(mm)	17.5	20.79	14.98	7.494	2.698	6.741	1.28
Parameters	W3	W4	W5	W6	W7	W8	W9
Values(mm)	3.741	8.24	3.80	3.9	8.24	1.456	6.749
Parameters	W10	W11	W12	W13	W14	W15	W16
Values(mm)	1.43	0.11	0.5	0.649	0.594	2.6	0.3

Fig .9 Dimension of antenna with parasitic element

A. At Lower frequency

Wavelength of lower frequency = 5*(substrate length +width of elements) = 5*(17.5+7.5)
= 125 mm
Frequency of lower band : C = 3* 108=125mm = 2.4GHz

IX. SIMUALTION RESUTS

A. Return Loss

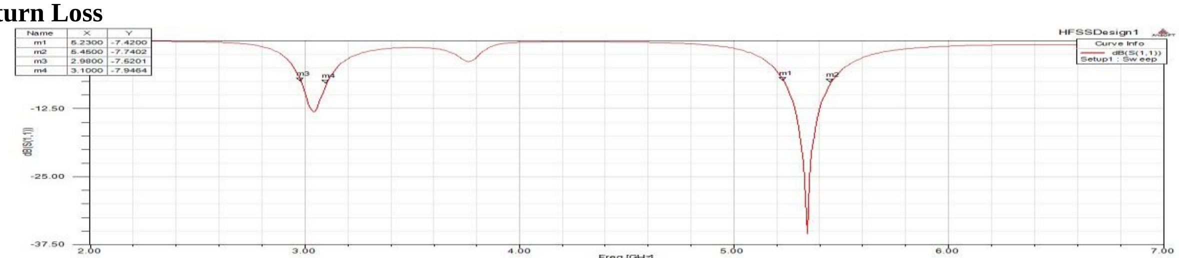

Fig 10.Return Loss of modified PIFA

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B. Radiation Pattern

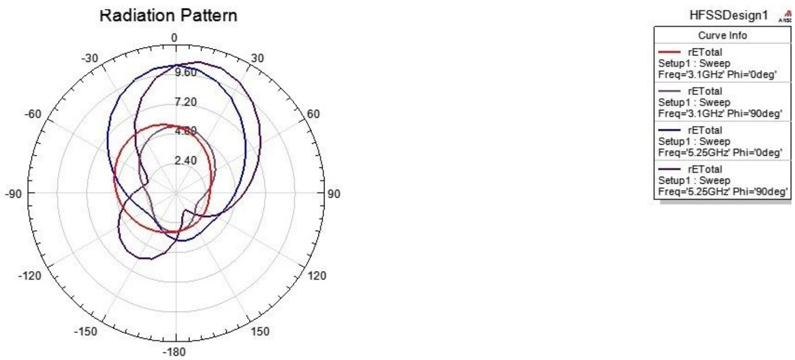

Fig. 11 Radiation Pattern

Radiation Pattern or Polarization, is describe in the H-plane (x-z plane) and E-plane (y-z plane). The main purpose of the radiation patterns is to demonstrate that the antenna actually radiates over a wide frequency band. It can be seen that the radiation patterns in X-Z plane are nearly omni-directional even at higher frequencies the proposed antenna has sufficient and acceptable gain level in these bands. [11].

Reason for bandwidth enhancement

Bandwidth is compare with parasitic element and without parasitic element

$$B = fu – fl /fc$$

fu, ; Upper, Lower frequencies and fc; Cut off frequency.

parameters	A	X
Upper band	5.2	0.042
Lower band	3.3	0.40

Where; A = Frequencies in GHz, X = Without parasitic element bandwidth
and Y = With parasitic element bandwidth.

X. CONCLUSION AND FUTURE WORK

The antenna configuration consists of a hook-shaped slot at radiating patch and a modified ground plane with a pair of square-ring and rotated I-shaped slots. The antenna can operate at 3.3 GHz WiMAX, 5.2 GHz WLAN, bands by experimental results .The modified structure an operating on dual band with introduced half-wavelength parasitic element is used comparing both return loss in fig.3 and fig.10 enhancement of upper band (BANDWIDTH) by 2 to 3 percentage increased. The possibility to design an MIMO structure with the same antenna on an extended ground structure. Two ports are assigned ,also verifying the self interference and forward/ reverse voltage values. Suggest methods to improve isolation between the MIMO antennas. then caluation Correlation,Mean Effective Gain, envelope correlation coefficient and Diversity Gain.

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