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A Broadband PIFA with Two Circular Slots on the Ground Plane for Mobile Applications

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ABSTRACT: ***The planar inverted-F antenna (PIFA) is widely used in mobile systems due to its excellent performance. Taking into account all the important parameters that significantly affect the Bandwidth in this paper, we present a new configuration of planar inverted-F antenna (PIFA) for mobile communication Application. Simulated results demonstrate that the new configuration covers S band like Bluetooth, SDMB, UMTS IMS And latest WIMAX and LTE frequency bands. Simulated return loss of the proposed antenna is acceptable over all the mentioned frequency bands. Overall size of the proposed design is 48.5 mm×19 mm×6.5 mm. In designing the PIFA, we propose a slots on the ground plane at 2.90 GHz resonance frequency for increasing bandwidth at about 200 MHz and frequency band 2.049- 3.270 GHz that around of this frequency, there are many wireless communication bands also gain is improve 3.36db from 1.5db. And return loss maintain -30db to -35db which is very good. Structural dimensions of the proposed antenna are optimized by using CST 2011.***

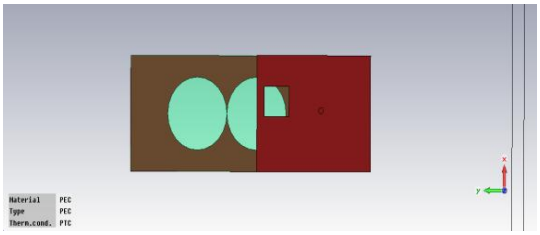
KEYWORDS: ***Cst 2011, Multiband Antenna, Planar Inverted-F Antenna (PIFA), SAR, Slots.***

I. INTRODUCTION

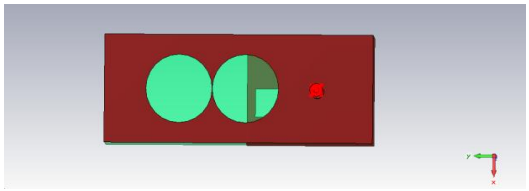
Recently, with the increasing interest in covering various frequency bands, attention was drawn toward the study of broadband antennas. For broadband antennas, achieving maximum possible frequency bands with suitable return loss and radiation pattern are desirable. Planar inverted-F antennas (PIFAs) can cover two or more standard frequency bands and due to their thin planar structures, they have been frequently used for mobile phone handsets. Also, PIFAs have features such as simple fabrication, lightweight, low profile and flexibility [2]-[4]. In this type of antenna structure, locating the ground plane below the radiation element of PIFA leads to reducing specific Absorption rate (SAR). [5] Due to low absorption of energy in the human body, this antenna provides good efficiency. In addition, little influence of electronic components of a mobile handset on the PIFA performance is considered as a significant advantage. Generally the basic PIFA radiator determines the frequency bands that can be covered. In addition, increasing the number of frequency bands or bandwidth of a specific frequency band can be provided by insertion of a slot in the ground plane in this paper, we present a new broadband PIFA antenna, Based on combination of a square slot in the radiating patch[2] and two additional circular slots in the ground plane.[8] Introducing slot in the PIFA radiating element and on its ground plane leads to creating high resonance frequencies and increasing the bandwidth, respectively [4].The proposed antenna operates at 2.90 GHz and frequency band is 2.049-3.270 GHz in this frequency rang cover(UMTS, 1.9-2.17 MHz) Universal Mobile Telecommunications Systems, IMS2.7 (2700-2900MHz) Industrial scientific medical, Bluetooth (2.42-48GHz),Satellite-Digital Multimedia Broadcasting(S-DMB,2605-2690MHz), and latest Wimax (2500-2690MHz) Worldwide Interoperability for Microwave Access, WLAN (2400-2484 MHz) And TDD-LTE (2.620-2.690) Long term evolution [5]-[6] Details of the proposed antenna design and results of its performance are studied in this paper. [1]

II. ANTENNA DESIGN & SIMULATION

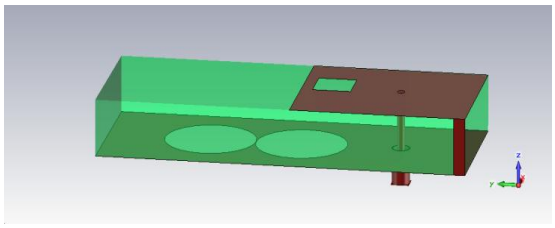
Fig.1 shows the configuration of the proposed multiband PIFA antenna for using in mobile handsets. The antenna geometry with total area of 48.5mm ×19mm is printed on a 6-mm thick substrate (εr =1). The square slot in the radiating element and two circular slots in ground plane of antenna provides multiband characteristic. Dimensions of slot configuration have been optimized using Computer Simulation technology (CST 2011) in order to achieve the maximum covering wireless communication bands with desired return loss.



(a)



(b)



(c)

Fig. 1. Geometry of the proposed multiband PIFA (a) top view (b) bottom view (c) 3-D view

The thickness between the basic PIFA radiating element and the ground plane is h=6 mm that is attractive for slim handset antennas. The slot on the ground plane is shown in Fig. 1 (b). In this paper, the location and the dimensions of the slot in the ground plane is optimized in order to increase the bandwidth to an acceptable value. The radiator element of PIFA is grounded with a shorting wall. The antenna impedance matching is achieved by controlling the distance between the feed-line and shorting wall. Optimized dimensions of the antenna are given in the Table I.

TABLE I: Dimensions of the proposed antenna

PARAMETER	VALUE
GL	48.5
GW	19
RL	23
RW	19
fL	11.5
fW	9.5
WW	1.5
SL	5
SW	5
DGS	12

Dimensions of the structure:

(1) The length of the radiator RL is about 1.25 to times the width of the radiator Rw to produce a rectangular radiator shape.

(2) The width of the radiator R_W and the ground plane width G_W are identical and are aligned.

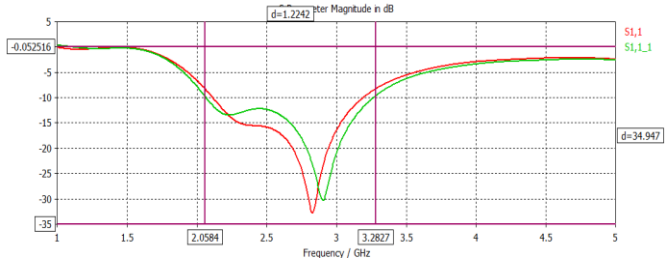
(3) The shorting wall width W_W which is placed along the length of the radiator.

(4) The prob feed is placed near the center of the radiator. The feeding position along the radiator's length and width f_L and fw are about $.5R_L$ and $.5R_W$ respectively.

(5) Here D_{GS} is diameter of ground plane slot.

(7) SL and S_W are radiating length and Width slot.

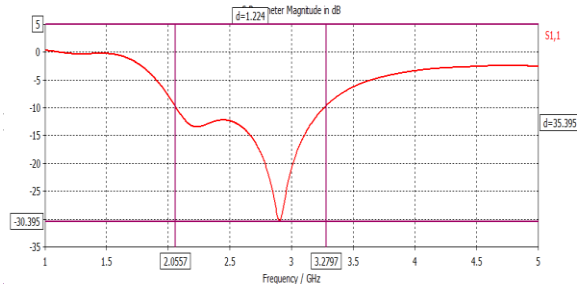
Fig. 2(a) shows the simulated return losses of two cases for the proposed antenna. Creating square slot on radiating patch-increasing bandwidth about 70MHz. than next When Creating slots on the ground plane causes increasing the bandwidth about 200MHz With directivity 3.34dbi and gain 3.36 db shown fig 2(c) and 2(d) respectively.



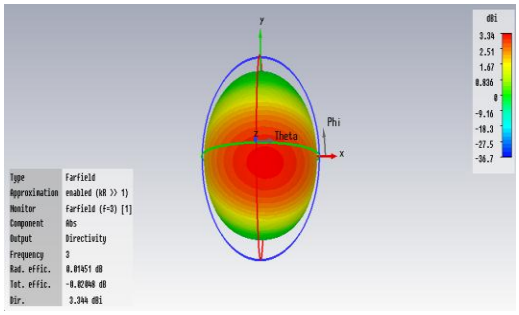
2(a)

Here red color show without ground cut and green color show with ground cut slot simulation result and get 1.224 GHz Bandwidth.

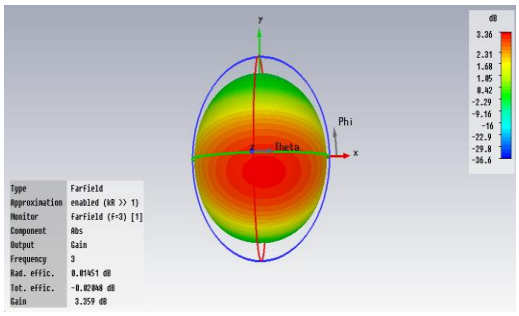
Figure 2(b) show final return loss Vs freq.



2(b)



2(c) Directivity



2(d) Gain

CST Microwave Studio was used in the design of the structures. Ideally, the bandwidth should be centered at a frequency of 2.45 GHz, which is calculated using an experimentally derived equation, for a plain, edge fed structure in

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

Here W_f is feed width 1mm

III .RESULT COMPARISON:

Parameter	Plain PIFA Simulated (Measured) (GHz)	Slotted PIFA simulated (Measured) (GHz)
f1	2.00	2.049
f2	3.03	3.270
BW	1.026	1.224
%BW	41.03	42.10
fC	2.51	2.90
Return loss	-35db	-31db
gain	1.5 db	3.36 db

We get some variations from our simulated results, like resonating frequency shifts to 2.90 GHz from 2.51 GHz. This is due to the fact that in slotting technique when we cut slots , some material is lost and we know the return loss of antenna should be less than -10 db , so for maintain this characteristics , a slight shift occurs in resonating frequency.

IV. CONCLUSION

In this paper, a new multiband planar inverted-F antenna has been presented to be useful for personal communication mobile applications. The proposed antenna has a simple configuration and is simply printed on substrate has a relative permittivity εr of 1. Improving the bandwidth has been obtained by adding two circular slots on the ground plane of this antenna. The effects of the square slot on the radiating patch and varying the radius of two circular slots in the ground plain have been investigated on the return loss. This antenna

can operate within the PCS, Bluetooth, DCS, SDMB Wimax, UMTS, and an additional frequency band, and provides good radiation patterns over these operating bands.

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