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Bandwidth Enhancement for PIFA Antenna Using Circular Slot in Radiating Patch and Ground Plane for Wireless Communication

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ABSTRACT: In the most recent days pifa antennas are mostly used in the wireless communication due to the salient features like low cost, less weight, small size. In this paper, a coaxial feed, slotted rectangular patch and ground plane antenna has been proposed. Bandwidth enhancement has been improved by suitably cutting slots into the rectangular patch and ground plane. Proposed antenna is suitable for various wireless applications. Representation, measurement and calculation for this new antenna have been done with the help of software CST microwave studio 2011**.**

KEYWORDS: CST 2011, Low Profile, Microstrip Patch Antenna, Planar Inverted-F Antenna (PIFA)

I.INTRODUCTION

IN RECENT years, the demand for broadband antennas has increased for use in high frequency and high-speed data communication. [2] Printed antennas are economical and easily hidden inside packages. Unfortunately, a "classical" micro strip patch antenna still they have the area to improve their bandwidth and to reduce their size, to make these more compact.[4] That precludes its use in typical communication Systems. However, if the frequency bandwidth could be widened, a broadband pifa antenna would prove very useful in commercial applications such as 2.5 G and 3 G wireless systems, and Bluetooth personal networks [5]. In contrast, PIFAs are radiating patches, that are kept parallel to the ground plate and are connected to the ground by a shorting plate or a shorting pin, making it defected. This structure radiates at quarter to wavelength.PIFA antennas are low profile antennas that can be easily incorporated into the communication equipments. [4]

The novelty of this work is the following; A PIFA topology is implemented, introducing a slot on the radiator, ground and utilizing a shorting wall instead of pins at a well-chosen location to broaden the bandwidth [6]. The introduction of the slot modifies the currents on the patch, resulting designed for operation in the 2.92 GHz ISM band. The proposed antenna structure is applicable in the Industrial, Scientific and Medical (ISM) band (2.40–2.48 GHz), Personal Communication Services (PCS, 1880-1990 MHz) ,Digital Communication Systems (DCS, 1710 1880 MHz), Universal Mobile Telecommunications Systems (UMTS, 1.9-2.17 MHz) Satellite-Digital Multimedia Broadcasting (S-DMB, 2605-2690 MHz), Bluetooth (2.42.48 GHz), and also in various newer applications, including International Mobile Telecommunication-2000 (IMT-2000) bands (1.92–2.69 GHz) and Long Term Evolution Time Division Multiplexing (LTE TDM) systems (1.90–2.62 GHz).[7]-[12].

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II.ANTEENA DESIGN

Figure 1(a) shows the 3D geometry of the Proposed PIFA antenna. The PIFA antenna has a miniaturized size of 48.5 × 19 × 6.5 mm.

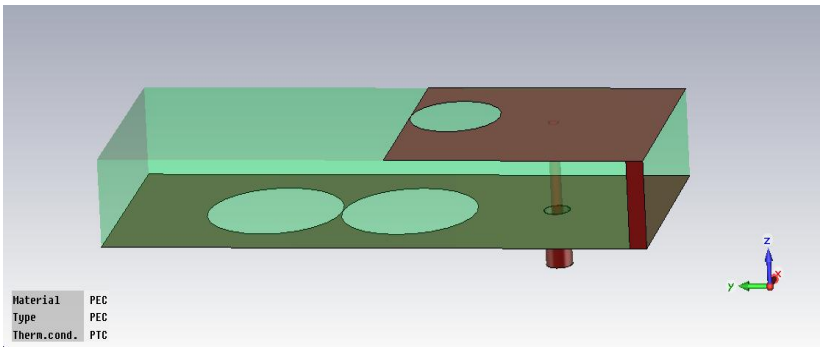

Fig.1 (a)

The antenna design has been simulated with CST-MWS simulation environment. The 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 × 19 mm. The bottom layer, considered as a ground plane, is of the size of 48.5 × 19 mm, which has been made smaller for making space for the other components of the mobile handset. The ground is made defected by making it short with the upper patch, with the help of a shorting plate of thickness 0.2 mm. The top and bottom copper layers are supported by the substrate layer of dielectric material relative permittivity εr of 1, and substrate height of 6 mm approximately. Figure1 (b), (c) show top and bottom view of proposed antenna.

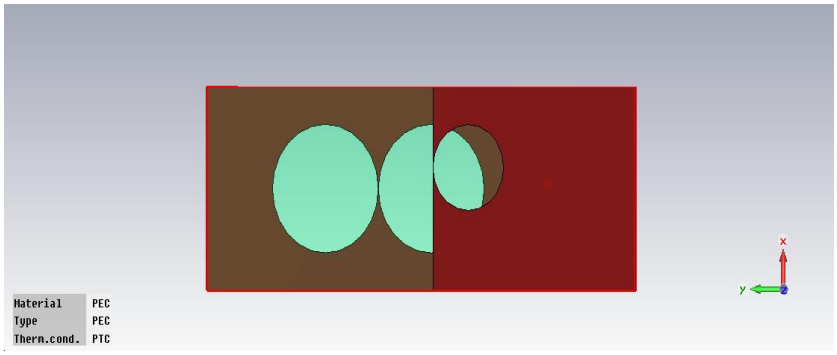

Fig.1 (b)

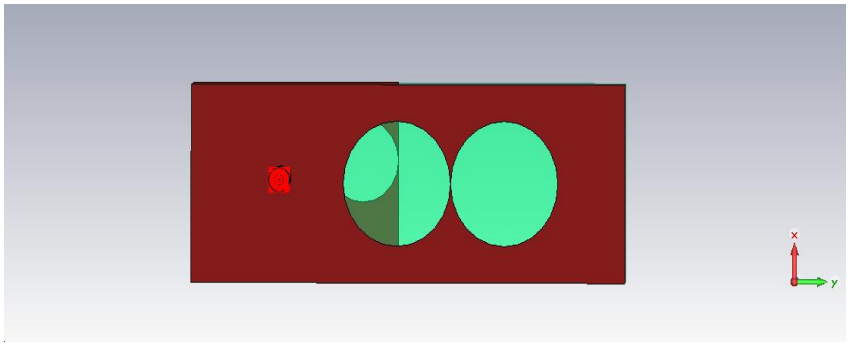

Fig.1(c)

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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 [3]

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

Here Wf is feed width 1mm and c is velocity of light.

Table 1: Physical Dimensions of the proposed PIFA (All in mm)

PARAMETER	VALUE
G_L	48.5
G_W	19
R_L	23
R_W	19
f_L	11.5
f_W	9.5
W_W	1.5
W_h	6.5
W_f	1
D_{PS}	8
D_{GS}	12
S_p	4

Dimensions of the structure: [2]

(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 Rw and the ground plane width Gw are identical and are aligned.
(3) The shorting wall width Ww 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 .5RL and .5Rw respectively.
(5) Here Dgs is diameter of ground plane slots.
(6) Dps is the diameter of radiating patch slot.

III.RESULT AND SIMULATION

Computer Simulation technology (CST) has been used to obtain simulation results. In this simulation, we assumed perfect electric conductor for the radiation element, the ground plane, shorting strip and feed line. The proposed antenna structure is tuned to provide enough impedance bandwidths to cover PCS 1900/DCS-1800//UMTS/SDMB /Wimax / /Bluetooth frequency bands with return losses less than or equal to -10 dB and with acceptable radiation patterns. Fig. 2(a) shows the simulated return losses of two cases for the proposed antenna. Creating slot on radiating patch increasing bandwidth about 70MHz. than next When Creating slot on the ground plane causes increasing the bandwidth about 200MHz for center frequency 2.92GHz. With directivity 3.33dbi and gain 3.35 db that is show figure 2 (c) and 2(d) respectively. [1]

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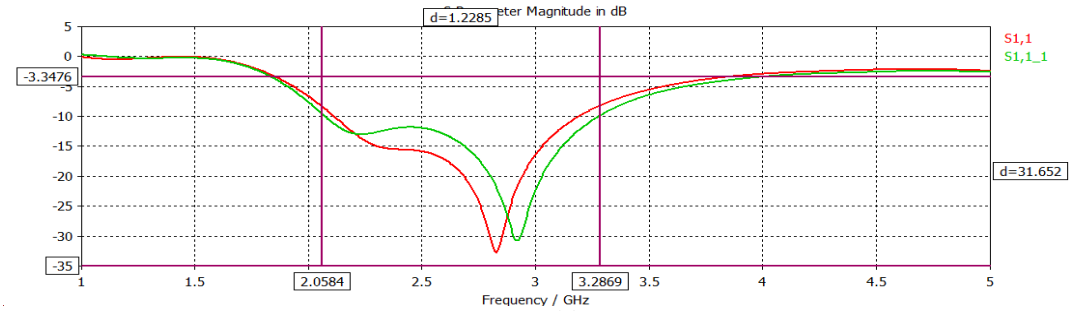


Fig.2 (a)

Here red color show without ground cut And green color show with ground cut Slot simulation result and get 1228 MHz Bandwidth

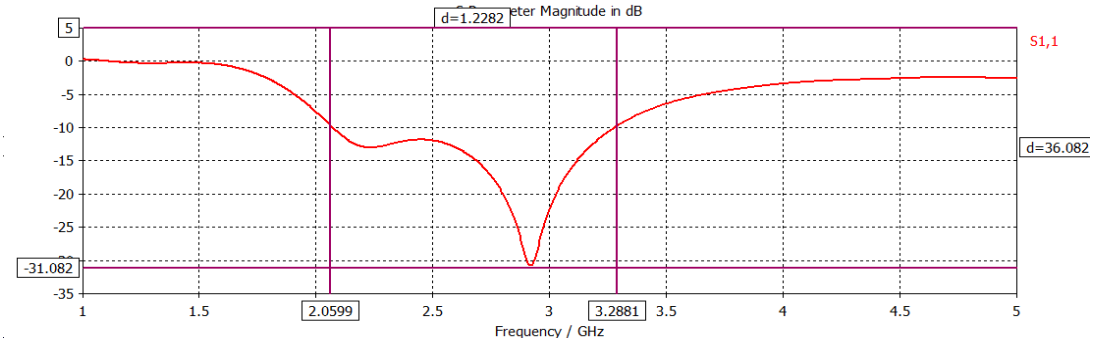
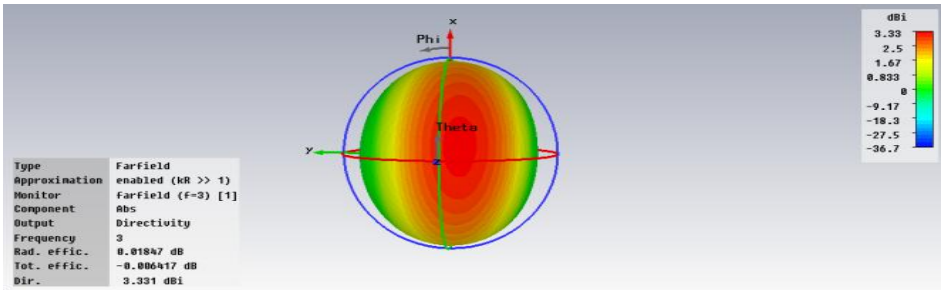


Fig.2 (b) show return loss Vs freq. final result



Directivity 2(c)

Here simulated directivity plot shown fig. 2(c) that is value 3.33 dbi which is show the propose antenna is omnidirectional antenna.

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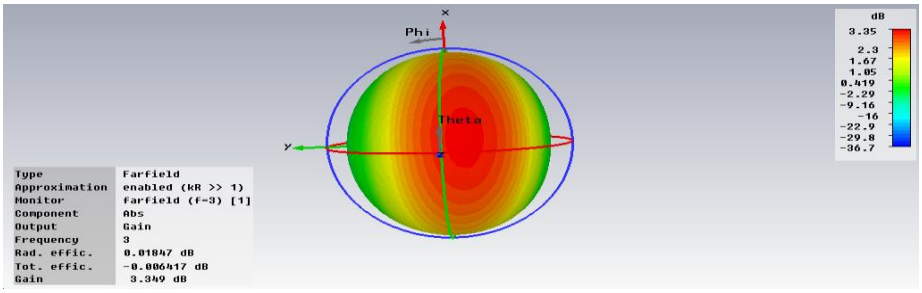
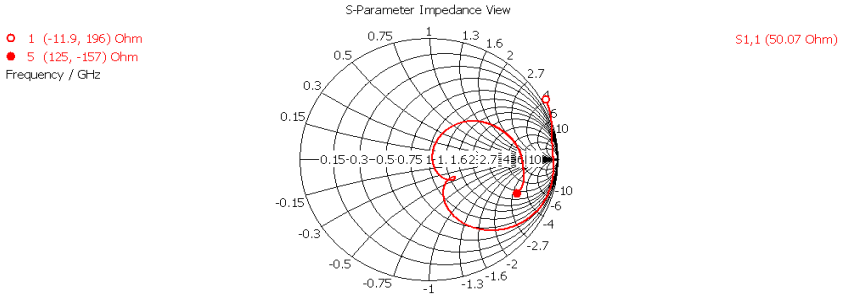


Gain 2(d)

Here simulated Gain plot shown fig. 2(d) that is value 3.35 db which is more than double (1.5 db) compare to plain antenna value that is very good for the propose antenna.



Smith chart

Here simulated smith chart show the input impedance of propose antenna that is 50.07 ohm at 2.92 GHz frequency that is very good for multiband characteristic.

IV.RESULT COMPARISION

Parameter	Plain PIFA Simulated (Measured) (GHz)	Slotted PIFA simulated (Measured) (GHz)
f_1	2.00	2.30
f_2	3.03	3.53
BW	1.026	1.228
%BW	41.03	42.12
f_C	2.51	2.92
Return loss	-35db	-32db
gain	1.5db	3.35db
εr	1.45	1

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We get some variations from our simulated results, like resonating frequency shifts to 2.92 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. Also εr shift to 1 from 1.45 causes enhance the bandwidth.

V. CONCLUSION

With the help of CST software simulator (V.2011), a pifa slot antenna is designed. Slots are incorporated on radiating patch and ground plane. The designed antenna successfully matches the desired characteristic (like return loss should be less than -10 db). The simulated and measured results show that antenna exhibit good electrical performance and thus can be considered as a suitable candidate for various wireless applications. In our research work, we studied different aspects related to pifa antenna and we have made pifa slot antenna at 2.92 GHz frequency with bandwidth 1228 MHz and % bandwidth up to42.12 %. The bandwidth of reference antenna was 1026 MHz, thus we can say that we have enhanced the bandwidth by 200 MHz, Gain is also improve 3.35db which is more than double to calculated value (1.5db) and return loss is maintained –30db to –35db that is very good.

ACKNOWLEDGEMENT

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