Design and Analysis of Planner Inverted F Antenna (PIFA) for GSM & 3G Application

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ABSTRACT

This paper layout design and analysis of planer inverted F antenna is presented. The proposed antenna has a suspended patch at a height of 6mm from the substrate. For this antenna probe feed technique is used. It is applicable for two different applications which include GSM & 3G technology. The proposed antenna has simple P shape patch. The overall dimension of the antenna come around 101mmX54mmX7.6mm and fed by 50Ω probe feed. Parametric analysis is done by varying gap between substrate and patch. Simulations are performed on HFSS v.11 software. From simulation the proposed antenna resonates at 870MHz and 2.1GHz with impedance bandwidth of 70MHZ & 85MHz respectively.

Keywords – **PIFA, GSM, 3G etc.**

I. INTRODUCTION

Recently, rapid development and growth in wireless communication technology lead to a demand of mobile terminal with multi-band operation for combined use of multiple functions. The antennas with multi-band operation have been investigated for multi-function mobile terminals. In mobile communications, several types of antenna structure are developed to be installed inside the terminal.

A microstrip antenna consists of a very thin metallic patch placed on conducting ground plane, separated by a dielectric substrate. A microstrip patch consists of a radiating patch of any planar geometry (e.g. Circle, square, Ellipse, ring and rectangle) on one side of a dielectric material substrate and a ground plane on the other side. Microstrip antennas have numerous advantages such as lightweight, low profile, easy fabrication and simple modeling.

The planar inverted-F antenna (PIFA) is a popular type of internal antenna since its small-sized, low-profile structure is advantageous in mounting inside the terminal. Also, the flexibility of PIFA structure provides the diverse use in designing internal antennas of mobile terminals. The basic PIFA element, however, has the disadvantage of narrow bandwidth; typically its bandwidth is about 5-10 % [1-6].

In this paper we present a Planner inverted F antenna with different shape of the patch. The designed antenna employs suspended patch to provide double resonance frequency which are located at 870 MHz and 2.1 GHz respectively. For this antenna shorting pin technique is used to achieve the broadband characteristics.

II. ANTENNA GEOMETRY

The complete geometry of the antenna is shown in fig.1.this proposed design of antenna consist, an FR4_epoxy dielectric material with ε_r=4.4 and dielectric loss tangent of 0.002 is selected for the substrate with 1.6 mm height. Length and width of substrate is 51mm & 104mm respectively. Then, a patch antenna that operates at the specified operating frequency f_0= 2.1 GHz & 870 MHz with suitable bandwidth can be designed with height, from the substrate is 6mm. The parameters of the antenna are specified in table.1. From the proposed geometry of PIFA, the radiating patches which is "P" (English letter) shape.

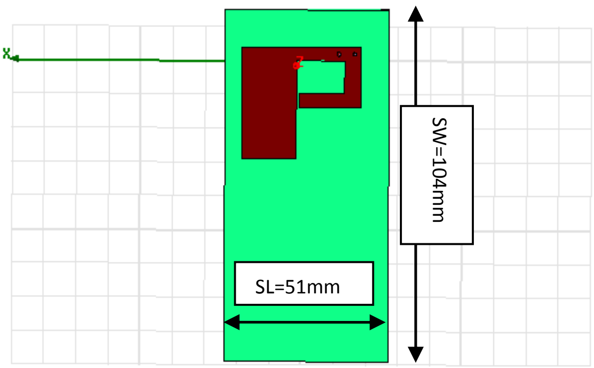

Figure. 1.Geometry of PIFA

The feeding probe is placed at upper right corner of the shape and shorting pin also placed near to the probe feed. The feeding probe is placed in a such a way that we get better impedance matching as well as the resonating length of $\lambda_0/4$ is achieved for both resonating frequency. fig.2. shows the radiating patch dimension.

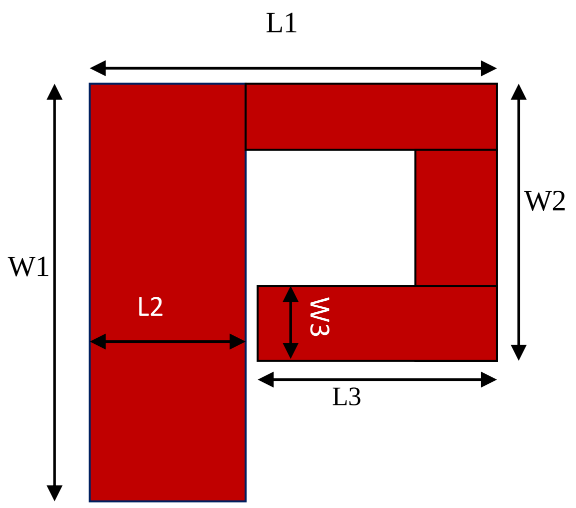

Figure.2.Patch dimension.

Table.1 Parameters of antenna

Design parameter	Dimension
L1	37mm
W1	33mm
L2	17mm
W2	19mm
L3	17.5mm
W3	4.25mm
W4	5mm
Substrate thickness	1.6mm
Gap between patch & substrate	6mm
Patch thickness	0.1mm
Substrate length sl	51mm
Substrate width sw	104mm

III. RESULT AND DISCUSSIONS

1. Return loss

For the proposed antenna design HFSS v.11 simulation software is used, which is full wave electromagnetic simulation software. Parametric analysis is done by varying the gap between substrate and patch, from the simulation we get better result by maintaining the gap of 6mm.ie for 870MHz we get the return loss of -16.7db with bandwidth of 70MHz between 840-910MHz and for 2.1 GHz we get return loss of -22db with bandwidth of 85 MHz between 2.06-2.145GHz.

In the parametric analysis, gap between substrate material and patch is changed i.e. 2mm, 3mm, 4mm, and 5mm and observe result in fig.3. From the above fig. we observed that, as the gap between patch and substrate material decreases resonant frequency decreases.

Also, the simulations are done with modified shape of the patch. First we remove the strip1 and observed that, antenna is resonates at a single frequency, 870MHz with return loss of -15.6db.Secondly we remove both strip 1 & 2, and antenna is resonates at 855MHz with return loss of -17.3db.

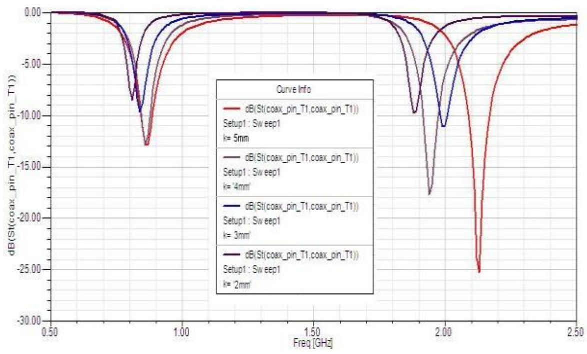

Figure.3. Parametric analysis of antenna by changing gap between patch & substrate.

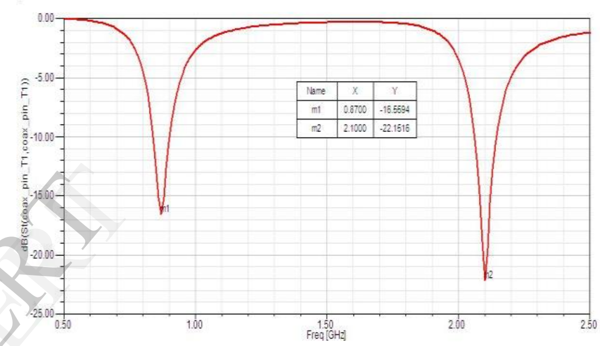

Figure .4. Return loss plot at gap of 6mm

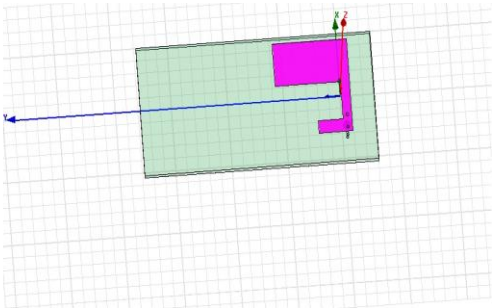

Figure 5. Strip 1 removed

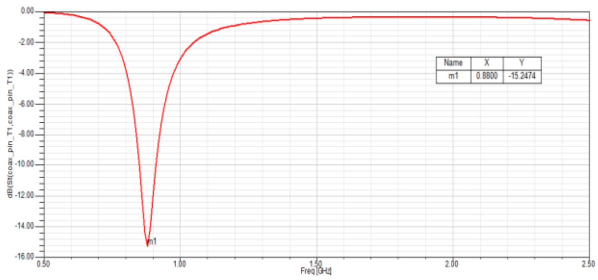

Figure 6. Return loss after strip 1 removed

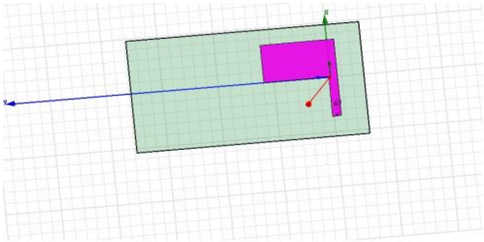

Figure 7. Both strip 1 & strip removed

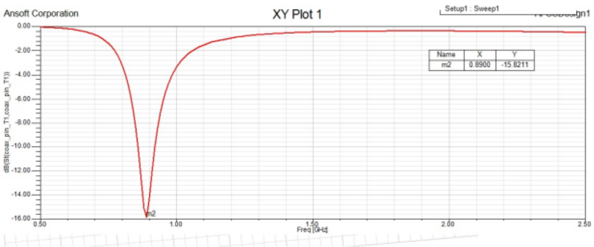

Figure 8. Return loss after both strip removed

2. VSWR

Voltage standing wave ratio VSWR which is a function of reflection coefficient represents the amount of power reflected from the antenna.

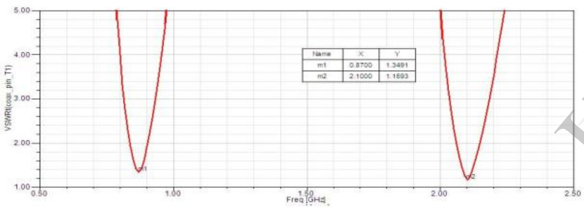

Figure 9.VSWR Plot

An antenna is considered to be perfectly matched when the VSWR value is between 1and 2. It is observed that VSWR is between 1 and 2 in the entire operating frequency range. The VSWR values at the two resonant frequencies 870MHz & 2.1GHz are 1.3491, 1.1693 respectively. The simulated VSWR vs. frequency curve of the antenna is shown in figure 9.

3. Gain

The gain of an antenna represents the amount of power transmitted in the direction of peak radiation to that of an isotropic source. It can be as high as 40-50 dBi for very large dish antennas and can be as low as 1.8 dBi for real antennas. Theoretically, it can never be less than 0 dBi. The gain of the proposed antenna is 2.9 dBi at 2.1GHz and 3.9 dBi at 870MHz.

4. Radiation Pattern

The Far-field radiation pattern at two resonant frequencies i.e. at 870 MHz and 2.1 GHz for Phi=0 degrees and Phi=90 degrees are shown in figure 10.1. & figure 10.2

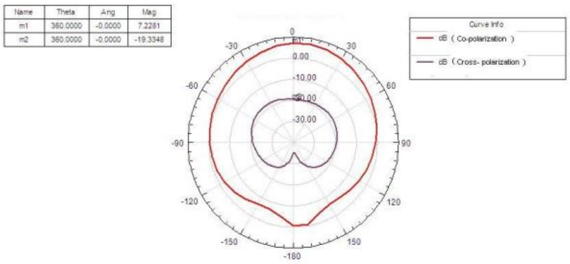

Figure 10.1. Radiation Pattern at phi=0 degree

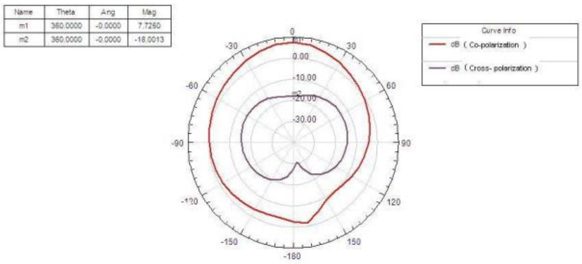

Figure 10.2. Radiation pattern at phi=90 degree.

5. Smith Chart.

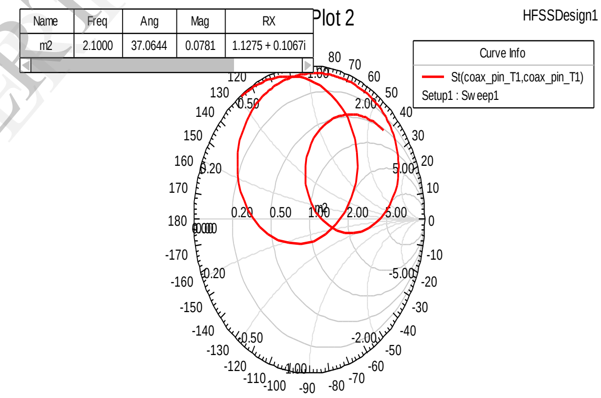

Figure 11. Smith chart

IV. CONCLUSION

A dual band probe fed planar inverted F antenna is presented. The proposed antenna is designed by using FR4 substrate material which is low cost and easy for fabrication. Therefore, the proposed antenna is a good candidate to use for many wireless communication systems such as GSM, 3G

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