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Planer Inverted Antenna using Meta Materials for Multiple Frequencies

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Abstract— **PIFA antenna have many advantages over micro-strip antenna as they have small size, light weight, and with enhance properties. PIFA structure is easy to hiding in casing of mobile hand phones as compared to other monopole , rod and helix antenna. Also, PIFA has reduced backward radiations towards user's body and head , reduces SAR and improves performance.**

The main disadvantages with PIFA is its narrow bandwidth therefore its necessary to widen its bandwidth to use it in mobile and other hand hold devices. We can enhance the bandwidth of antenna by changing its dimension parameters, substrate materials etc. So using META materials as substrate we can enhance the bandwidth as well its directivity.

META material, is an artificial material have a property of having negative value of E(epsilon) and u(mue). And also known to having negative refractive index or left handed LHM. In right handed materials ray is reflected towards the normal but in LHF ray is reflected away from normal thus produces focus inside the material.

Thus by using Meta material we can enhance the gain, bandwidth, and due to the use of left handed material we can also enhance the directivity too.

In this project we have enhance the bandwidth so that antenna can be use for the multiple frequencies i.e. for WIMAX, BLUETOOTH, WLAN. And we will do the same using the META materials as substrate layer for this purpose.

Keywords—Pifa, gain, coaxial feed, meta materials return loss.

1. INTRODUCTION

In today's cellular system there is need of compact size of antenna, with good efficiency, large bandwidth. Generally, the patch and micro-strip antennas used have size in the range of $\lambda/2$. However the increasing demand of compact size devices has led us towards PIFA having dimensions in the range of $\lambda/4$. Narrow bandwidth characteristic of PIFA is one of the limitations for its commercial application for wireless mobile.

The main problem faced during antenna designing is to improve the efficiency and performance. Nowadays, the researches in antenna mainly focus on enhancing the bandwidth and improving efficiency and at the same time ensuring a compact size that is the demand of today's communication era. This led to the increasing use of PIFA for handheld devices.

Now a days PIFA is widely used in many radio and household devices because of compact size and increased efficiency, low profile and Omni-directional.

The distance between the shorting wall and the feed pin is the controlling factor for the impedance. Impedance is directly proportional to the distance between the feed and the shorting wall i.e. lesser the distance less will be the impedance.

2. ANTENNA DESIGN

The dimension of the proposed PIFA are 15x18x7.8mm. The ground plane is chosen as rectangular plane. The thickness of substrate is taken 3.8mm above the ground plane. Coaxial feed is chosen with the radius of 0.5mm and the height equal to that of the substrate. The shoring plane have dimensions as 1x3.8mm inserted between the ground and the substrate.

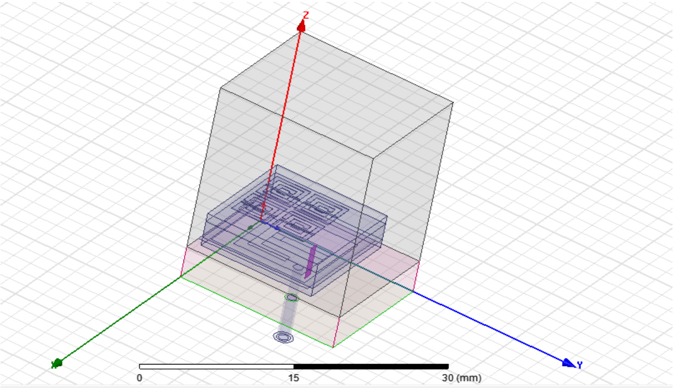

Figure1: Proposed antenna design

The substrate have the relative permittivity of 4.4 (FR4 EPOXY),with loss tangent 0.02 and the feed is made using the PEC material, and the shorting plane is chosen to be conducting provided E-field.

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The meta material layer is made with SRR(with two rings) as the unit cells.

3. DESIGN PARAMETERS AND SPECIFICATIONS

Relative Permittivity of Substrate=4.4

Table 1: various design parameters

Parameters	**Dimensions**
Ground	15mmX18mm
Substrate	15mmX18mmX3.8mm
Meta-material layer	13mmX13mmX2mm
Feed line	Radius=0.5mm, height=3.8mm
Shorting	1mmX3.8mm
SRR unit cell	4mmX4mmX0.02mm

4. SIMULATED RESULTS

The results for the designed antenna are calculated and studied in HFSS. The S11 parameter versus frequency graph is plotted and the multiple frequency as shown in below plot-

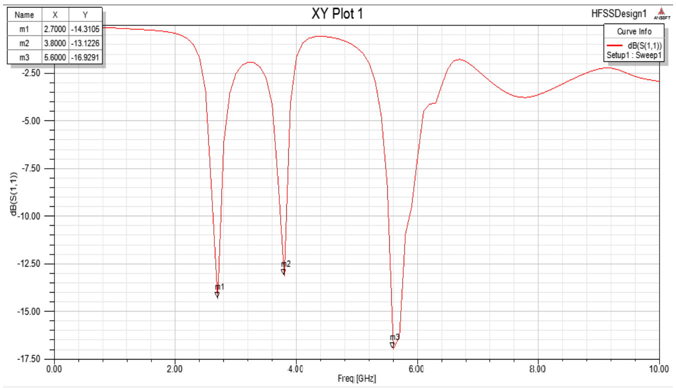

Figure2 : Return Loss versus Frequency

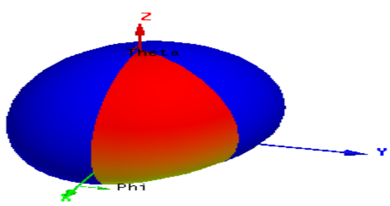

Figure3: 3-D Radiation Pattern

The figure 2 and figure shows the S11 s-parameters versus frequency and 3-D radiation pattern respectively.

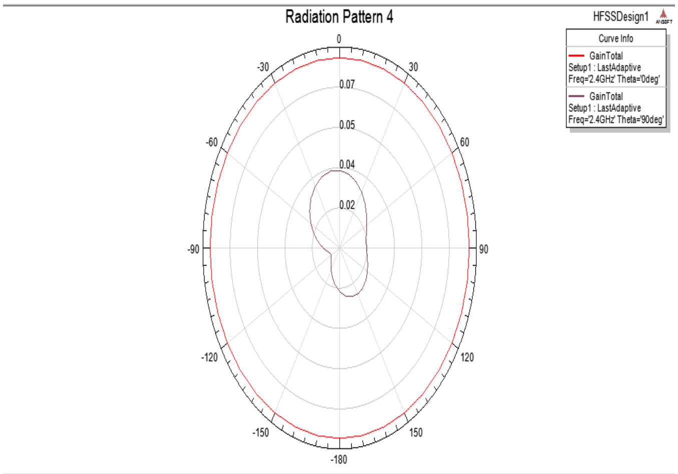

Figure 4: Plot for Gain

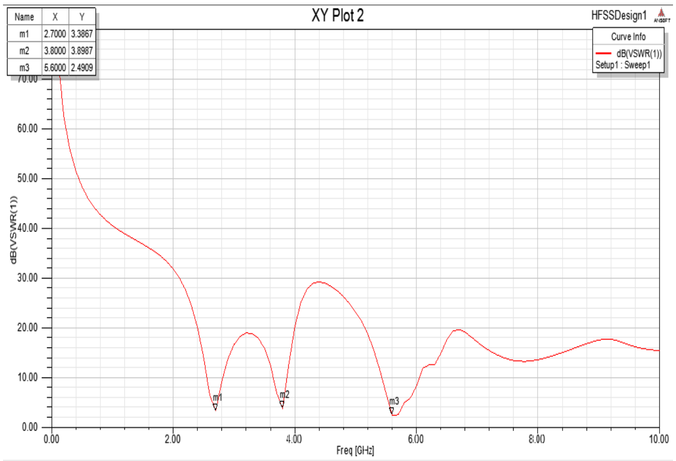

Figure 5: Plot for VSWR

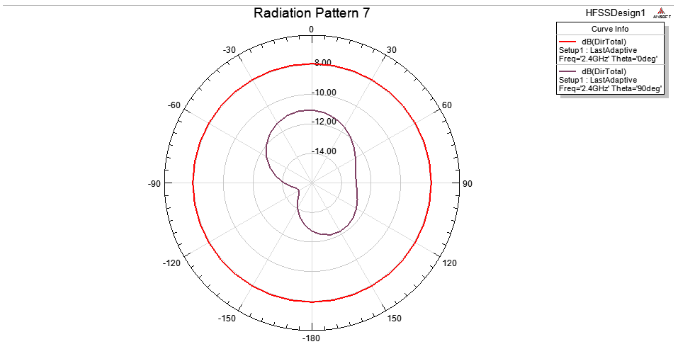

Figure 6: plot for directivity

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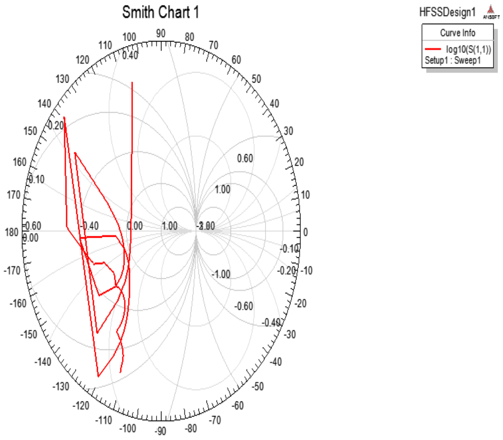

Figure 7: Smith Chart(log)

5. CALCULATED RESULTS

Return loss at frequency at 2.6GHz is -14.3105db and at frequency 3.8 GHz is -13.1226db and for 5.6GHz -16.9291db.

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Frequency sweep at 2.4 GHz.
Bandwidth at 2.6GHz is 113.8MHz.
Bandwidth at 3.8GHz is 97.9MHz.
Bandwidth at 5.6GHz is 329.7MHz.

6. CONCLUSION

The designed antenna is supporting Bluetooth and WLAN frequency ranges with the central frequency of 2.6GHz, 3.8GHz and 5.6GHz with 113.8MHz, 97.9MHz and 329.7MHz respectively. Thus an antenna with a compact size, greater efficiency and more bandwidth is successfully designed.

However, further changes and modifications in the design can be made.

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