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Comparative Analysis of PIFA and Elliptically Inset Fed Antenna for Ultra Wide Band Applications

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ABSTRACT: This paper projects a comparative analysis of ultra-wideband antennas. It involves the synthesis of a PIFA planar antenna and an elliptical inset fed antenna. Firstly, the PIFA planar antenna (with dimensions in cm, x: 23.7, y: 31.6) are synthesized at an operating frequency of 2.4 GHz. After this, an elliptical inset fed antenna are synthesized at an operating frequency of 13GHz. Their gain and bandwidth is separately calculated for antenna. In this paper PIFA Planar antenna is analysed and compared with elliptical inset fed antenna. Elliptical inset fed antenna more suitable for usage. All simulations are done using the software CST Studio. The substrate material is made up of Duroid.

KEYWORDS: PIFA Planar, Elliptical, Gain, Duroid

I. INTRODUCTION

Wireless mobile communication has been at boom in the present times. Miniaturization has been the aim of every electronic component developer. A small antenna is the foremost requirement in any mobile device, to serve this purpose. To cater to this demand, a patch antenna seems to be the best bet available. Apart from suffering from many disadvantages like narrow bandwidth and low gain, a patch antenna has many advantages and useful traits. Many beneficial techniques have been suggested to transcend these limitations. Increasing the gain and widening the bandwidth have always been the key motive to advancement. To meet the functionality, multiple resonance [1] has always been the main concern in mobile telephony.

In this paper, an in-depth analysis is carried out on PIFA [2] antenna and an elliptically inset fed patch antenna for their performance, based on several parameters. At first, the PIFA antenna having a planar geometry is successfully simulated using the software. The return loss [3] plot of this antenna gives us a detail about the bandwidth of the antenna. Also, the 3dB plot gives us an idea about the gain of the antenna. After simulating the PIFA antenna, an elliptically inset fed patch antenna is simulated using the same software. This is done to bring a contrasting analysis and difference between the performances of this antenna in the ultra-wideband frequency range [4], when compared to a PIFA antenna. On designing the antennas, and checking the results of the simulation, we get to see a huge difference in the efficiency of the antennas. The results are then encapsulated in the paper. Fig 1 shows a conventional patch antenna structure.

II. OVERVIEW OF PATCH ANTENNA

In a patch antenna, the patch is the primary component which radiates electromagnetic energy [5]. To radiate energy, this patch must be made up of a conducting material. Copper is one such material. Shape of the patch is not a constraint in any patch antenna. The feed lines along with the patch, are subjected to photo etching. The ground plane [6] is also involved. In the antenna, the patch is of multiple shapes like triangular, elliptical, square, or circular, rectangular. In case of a rectangular patch, the length, L alter as $\lambda/3 < L < \lambda/2$ where λo signifies wavelength (free space). Dielectric

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constant$\in_r$, of the substrate has a value between $2.2 \leq \in_r \leq 12$. An extremely fine patch is chosen such that its thickness t< wavelength (free space).

Material of the substrate can differ as per the requirement of the simulation. Dielectric constants are subdivided into three categories. High dielectric constants have values more than 10, medium dielectric constants have the value of 6.2 and the low dielectric constant $\in_r$ have nearly a value ranging from 2.2 to 3 [7]. In this process of designing an antenna, preference is given to a wide substrate having less value of constant (dielectric) as it has more pros than cons. It leads to maximising the antenna size but on the other hand leads to massive bandwidth and perfect radiation. Consequently, the use of higher value dielectric constant (more than 10) is a must. Accordingly, adjustment is compulsory between performance and dimension of the antenna.

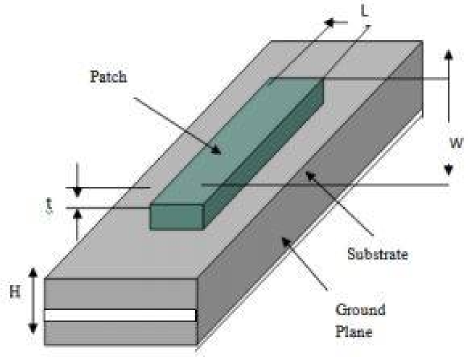

Fig. 1 Structure of conventional patch antenna

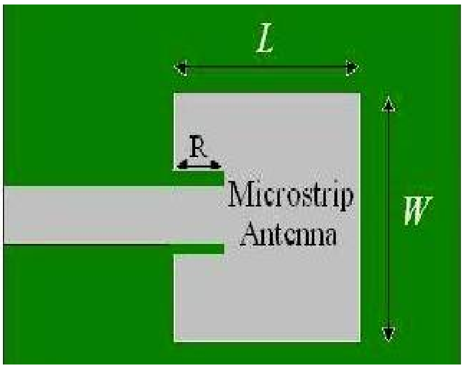

Fig. 2 A patch antenna with microstrip feed

Using a direct feed to the antenna, causes high impedance to occur across the terminals. As illustrated clearly in Fig. 2, application of a feed (inset) at a distance R establishes to be an efficacious method to reduce the value of input impedance. Value of the input impedance is proportional to the distance of the feed from the centre of the antenna.

III. PROPOSED METHODOLOGY

To begin with, an antenna using PIFA planar will be designed for 2.4 GHz. Accordingly, the specifications of the antenna are intended using the below relations. Subsequent values of the parameters utilized are shown in Table 1. The equations mentioned below are the basis of calculating the values of the parameters of the antenna:

A. Patch Width(*W*)

$$W = \frac{c}{2f_0}\sqrt{\frac{2}{\in_r+1}} \qquad eq.\ (1)$$

B. Patch Length(L_{eff})

$$L_{eff} = \frac{c}{2f_0\sqrt{\in_{r_{eff}}}} \qquad eq.\ (2)$$

C. Length of feed line(L_{feed})

$$L_{feed} = \frac{\lambda}{4\sqrt{\in_r}} \qquad eq.(3)$$

Where, $\in_r$ = Dielectric Constant (Substrate)
f_0 = Operating Frequency
c = Free Space Velocity (of light)

Additionally, the elliptical inset antenna are simulated. The designing of the PIFA planar antenna involves measuring the parameters very accurately.

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TABLE I
PARAMETERS USED IN SIMULATION

Parameters	**Values (in cm)**
Substrate thickness	63mm
Feed Offset	0.49
Feed lenght	0.015
X-dimension	4.9
Y-Dimension	9.9

The parameters of the main PIFA planar, the height and the gap are all taken into consideration for the analysis of the antenna at different configurations. The software used to create models of the antenna and display their return loss plots is CST Microwave Studio.

IV. ANTENNA GEOMETRY

A PIFA antenna is highly usable in a mobile phone and other similar devices. Thus, the geometry of this antenna is a very important factor.

Any Inverted F Antenna (IFA) basically has aa short circuiting pin (or plate), planar element (rectangular in shape) placed on a ground plane, and a mechanism to feed the planar part. Inverted F antenna can be understood to be a modification of the monopole in which top section is folded such that it becomes parallel to the ground plane. This leads to reducing the height of the antenna. Capacitance along with the input impedance to the antenna is introduced using this parallel section. Use of a short circuit stub helps in compensating this induced capacitance. The end of the stub is connected to the ground plane.

Fig. 4 shows a planar PIFA antenna. In this design, all the boundary conditions are applied effectively according to the design. The return loss curve obtained from this antenna is shown in Fig. 5.

Now, a new antenna is designed which is depicted in Fig. 6. This is an elliptically inset fed patch antenna. Measurements of the patch, ground, substrate and feed are taken very accurately.

Then the model of this antenna is created and thus the gain, bandwidth and other useful parameters are observed. The return loss thus obtained from this antenna has been depicted in Fig.7.

Aperture feed, Inset feed, Proximity Coupling and Pin feed, are some of the techniques used for feeding energy to the antenna [7].

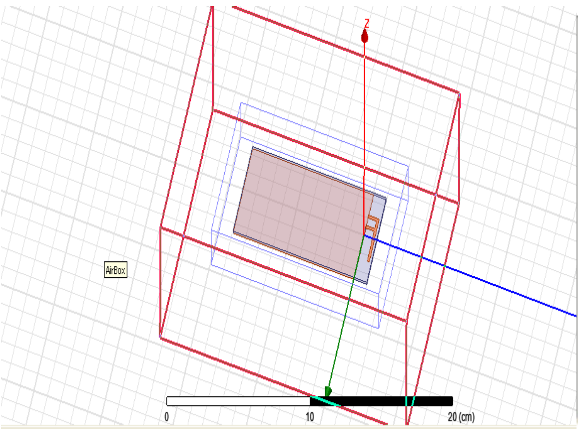

Fig. 4 Design of PIFA (planar) Antenna

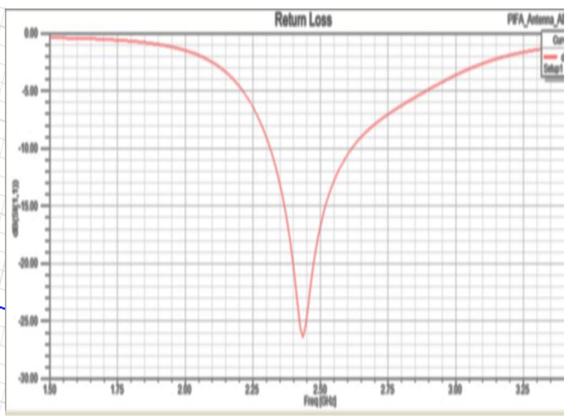

Fig.5 Plot of Return Loss (PIFA)

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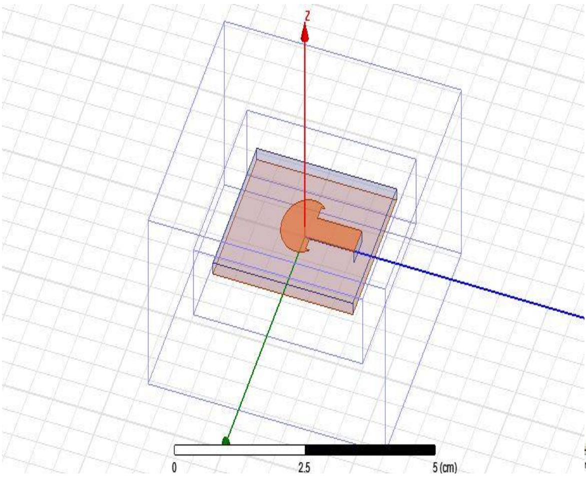

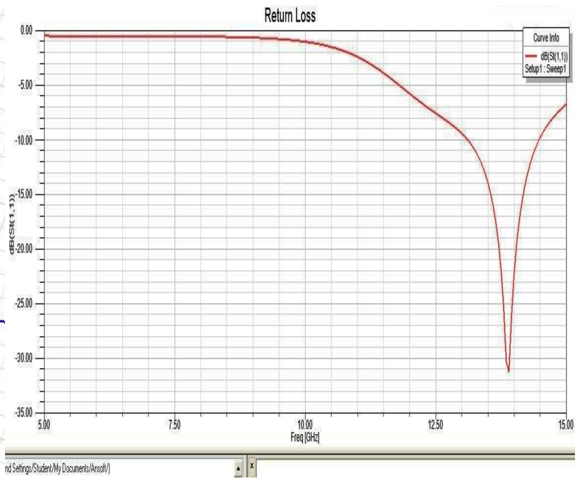

Fig.6 Design of elliptically inset fed Antenna Fig.7. Plot of Return Loss (Elliptical Antenna)

V. SIMULATION OUTCOMES AND RESULTS

Return Loss basically depicts the mismatch in the antenna. It may be understood as the inverse logarithmic ratio of the input power and reflected power from the antenna.

The correlation between return loss and VSWR can be expressed using the following expression:

$$ReturnLoss(indB) = 20\log_{10}\frac{(VSWR)}{(VSWR-1)} \qquad eq.(4)$$

Fig.5 illustrates clearly, the return loss of the first antenna. It is a PIFA planar. It comes out to have a resultant bandwidth of 300MHz and a gain of 6.2dB. After this, the bandwidth of the elliptically inset fed antenna is noted from Fig 7. It comes out to be 1400MHz.

For convenience, the above results have been summarised in Table II.

TABLE II

SUMMARY OF OBSERVATIONS FROM SIMULATIONS

Antenna Designed	**Frequency (GHz)**	**Bandwidth (MHz)**	**Gain (dB)**
PIFA planar	2.4	300	6.2
Elliptical inset fed	13	1400	9.4

VI. CONCLUSION

Various antennas were designed and studied for their efficient use in the ultra-wideband applications.. These antennas can easily be used for the purpose of wireless communication.

After studying these antennas, it is concluded that an elliptically inset fed antenna is much more beneficial, effective and highly desirable for UWB usage, than a normal PIFA antenna. The bandwidth of this elliptically inset fed antenna is around 400% more than the bandwidth of the normal PIFA antenna.

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REFERENCES

1. Nishant Kaul, A. Gupta, S. Bhat and S. Sah, "An inset fed patch antenna with a modified slot for WLAN and WiMAX applications," Green Computing and Internet of Things (ICGCIoT), 2015 International Conference on, Noida, 2015, pp. 163-167
2. Nishant Kaul, S. Bhat, A. Gupta and H. Chaurasiya, "Effect of parasitic patch configurations on multi-banding of microstrip antenna" 2015 4th International Conference on Reliability, Infocom Technologies and Optimization (ICRITO) (Trends and Future Directions), , Noida, 2015, pp. 1-4.
3. W.-C. Liu, M. Ghavami, and W.-C. Chung, "Triple-frequency meandered monopole antenna with shorted parasitic strips for wireless application," IET Microwaves, Antennas and Propagation, vol. 3, no. 7, pp. 1110–1117, 2009.
4. Wood, C, "Curved microstrip lines as compact wideband circularly polarised antenna", IEE J. Microwaves, Opt. &Acoust, 3, pp. 5-13, 1979.
5. Pues H. F. and Van De Capelle A. R. "Impedance-matching of microstrip resonator antennas", Proceedings of the North American Radio Science Meeting, Quebec, p. 189, 1980.
6. Dubost, G., Nicolas, M. and Havot, H. "Theory an applications of broadband microstrip antenna", Proceedings of the 6th European Microwave Conference, Rome, pp. 21S-219, 1976.
7. Ramesh, M and Yip KB, "Design Formula for Inset Fed Microstrip Patch Antenna", Journal of Microwave and Optoelectronics, Vol.3, No.3, December 2003

BIOGRAPHY

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