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Design of Planar Inverted F Antenna for 5G Applications

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ABSTRACT-Planar inverted F antenna is widely used in evolution of quarter wave monopole antenna. It Consist of monopole antenna running parallel to ground. Its most wide Spread use is as PIFA in mobile wireless devices for its space saving properties. PIFA is more comfortable than patch antennas liked based on cost, manufacturing, demand. Its typically consist of rectangular planar element which is located above a ground plane, shape appears like an inverted F hence known planar inverted F antenna also known as short circuited microstrip antenna. It supports multiple frequencies high gain and have promising future in wireless technologies. It has compact low profile design and shows omnidirectional radiation pattern with minimal hand effect. This F antenna is designed at frequency of 2.45GHz. To improve the performance of the antenna it looks for creative ways. One method used in patch antenna design is to introduce shorting pins (from the patch to the ground plane) at various locations. The Planar Inverted-F antenna (PIFA) is increasingly used in the mobile phone market. The antenna is resonant at a quarter-wavelength (thus reducing the required space needed on the phone), and also typically has good SAR properties.

KEYWORDS: Quarter wave monopole, wide spread, Microstrip antenna, Omnidirectional, Rectangular planar.

I.INTRODUCTION

planar inverted F antenna PIFA is used in wireless communication like in mobile phones. It uses frequencies like ultra-high frequencies and microwave frequencies. This antenna is resonant at quarter wave length as well as it is a type of microstrip antenna. PIFA typically has good SAR properties (Specific absorption rate). SAR measures the rate of radio frequencies in GHZ. PIFA is one type of patch antenna. It Consist of monopole antenna running parallel to ground. PIFA is more comfortable than patch antennas liked based on cost, manufacturing, demand. Its typically consist of rectangular planar element which is located above a ground plane, shape appears like an inverted F hence known we call it as planar inverted F antenna.It is also known as short circuited microstrip antenna because of 2 shorting pins. To improve performance, we use shorting of pins in different locations. By shorting pins, we have few advantages like size reduction, multi frequency resonance, gain improvement and desired radiation pattern. It supports multiple frequencies high gain and have promising future in wireless technologies. It has compact low profile designand shows omnidirectional radiation pattern with minimal hand effect. For low frequency elements it would deliver 0 power and for high frequency elements when decrease impedance and increase in radiation pattern then there will be impedance matching. In parallel condition the resulting impedance will be decreased which will find impedance matching in free space so that we can optimize the radiation characters. Impedance should match to antenna so that we can deliver maximum power and it is controlled via distance of short pins. The closer the feed is to shorting pin impedance will decrease. PIFA has a large single ground plane which supports the circuit board and touch screen of the mobile phone. PIFA can be designed from 3 to 30GHz with small form factor, bandwidth and gain. PIFA antenna actually has the same current-voltage distribution as it a half wave patch antenna. The performance of the antenna will depend on the position of the ground plane and increasing the ground plane will leads to decrease in the resonance frequency but not much. If we increase the height of the feeding lines it causes increase in the gain and as well as bandwidth. PIFA has the backward radiation which minimize the electromagnetic wave absorption. PIFA supports operations like wide band and multi band type operations. In this project we need use software like HFSS (high frequency structure simulator) in this software we need give all properties like ground, substrate, patch with all the dimension values. According to our boundary destination only the radiations will be occurred and signals will be passed. In this article of Planar inverted F antenna, uses 2.45GHZ to design.

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II. LITERATURE SURVEY

1.S.S. ALJA [1]: In this paper you going to see about planar inverted L antenna (PILA) for mobile handset application. PILA have low profile as well as bandwidth. It covers almost mobile communication system frequency band like 2G,3G,4G. PILA can cover Bluetooth and SDMB frequencies band. PILA compresses a small top plate which is fed to the ground plane. The frequency range of PILA is 1700MHZ to 2700MHZ.It has less gain, Narrow bandwidth, low efficiency and has slow response.

2.C. SAIRAM, BV. SRIVATHSAV [2]: In this paper the whip antenna is designed, and it is uses frequency like 30-100MHZ.It can be simulated using software HFSS (High frequency structure simulator) It has narrow bandwidth and less VSWR i.e., 2.5. If we want toincrease the bandwidth, we need a matching network it needs separate genetic algorithm to design a network. The whip antenna is high cost, as poor gain, difficult to tune and has narrow bandwidth.

3.**AHMED JAMAL ABDULLAH [3]:**This is the paper of helical antenna; it is an electromagnetic radiator which conducts wire wound in the form of screw threads. The radiation is maximum in the direction of helical axis and it is circular polarized.it is operated in the frequency of 10.16dB gain. Microstrip antenna is has high demand in the market because it has different radiating patches, feeding technique and substrate as well as several advantages over antennas like low cost, light weight, easy to feed and their attractive radiation characteristics. The Helical antenna is operated in the frequency of 2.4GHz.

4.SATISH SHEKLE [4]: In this paper represents about the design of rectangular microstrip antenna, frequency range of microstrip antenna is 2.4GHz. microstrip antenna uses ISM band and UWB applications. It provides -10db and also it is designed for obtaining low SAR models. It has low efficiency, low gain, large ohmic loss and low power handling capacity. In this paper the disadvantages can be recovered by 3 parameters by using variety microstrip antenna topologies, microstrip antenna based composite antenna permission and advanced machining techniques and for the microstrip antenna. It is developed for the wide range of applications.

5.ZHEN CHEN [5]: In this paper a Multiple input multiple output (MIMO) antenna is used with wideband application performance of 5G mobile communication. First the PLFA is introduced by the inverted T antenna. It operates in wideband of 78% because of multimode technology. The two PIFA'S are merged and form a pair with 2x2 sub-MIMO antenna with same bandwidth. It has high bandwidth that is 10db.If we use 4x4MIMO then it covers the 5GNR frequency bands.

6.TANVEER AHMAD [6]: Here the author designed a simple printed frequency reconfigurable microstrip PIFA antenna using two PN diodes. This antenna is presented in compact size of 44×14 mm^2. The diodes are inserted in radiation element by adjusting ON or OFF states of pin. The antenna has six different frequencies GSM850/900, GLONASS 1616, DCS 1800, PCS 1900, and UMTS 2100.F shape consists of radiation with ground plane mounted on substrate. It is an omnidirectional radiation pattern.

7.MAHAMMEDI NASSIM [7]: The author designed the paper on the impact of the defected ground structure using PIFA antenna and the mathematical analysis on antenna using finite element methane in the form of gain and matching impedance network. PIFA is proposed based on the configuration of fishnet metamaterial etched to the ground plane. It shows the dual band frequency at 3.9GHZ and 5GHZ it has return loss, Efficiency of 92.50%, gain of 3.11db.

8.MOHAMNAD S SHARAWI [8]: In this novel the printer is connected to the printed inverted F antenna (PIFA) with multiple input multiple output (MIMO). The array which is designed it is operated at 28GHZ for 5G mobile application. It consists of 4MIMO antenna and each MIMO consist of eight PIFA antenna. The array is operated with frequency of 28GHZ and bandwidth of 1GHZ from 27.5 to 28. 5GHZ.The dimensions of substrate are $130x68x0.76mm^3$ it matches to the dimensions of smart phones.

III.PROPOSED SYSTEM

A planar inverted f antenna (PIFA) is proposed for mobile application systems. The antennas are always thinks to create a new technology idea to improve performance. The antenna consisting of substrate, ground plane, microstrip patch antenna and feeding lines which is used for giving the input. We are using two shorting pins by this shorting pin

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this illustrate two quarter wavelength patch antenna which leads the shape of an inverted F so we call it as planar inverted F antenna. It is one type of microstrip antenna to improve performance we are using shorting pins at different locations. By shorting of pins, we have few advantages they are size reduction, multi frequency resonance, gain improvement, desired radiation pattern. It is a Resonant at quarter wave length and has good SAR (specific absorption rate) properties. The resonant frequency of PIFA is 2.45GHz.

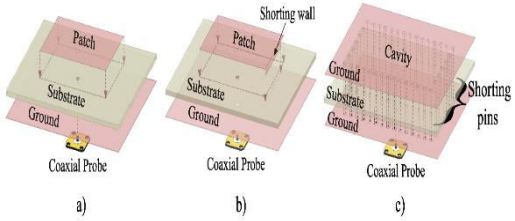

Fig:1 Layers of planar inverted F Antenna

The planar inverted F antenna (PIFA) is mainly used in mobile phone application. The antenna is resonant at a quarter wavelength which reduces the required space needed on the phone and typically has good SAR properties. A quarter wavelength patch shorted at the far end of the ground plane. Because the patch is shorted at the end, the current of the patch antenna is no longer forced to be zero. This antenna actually has the same current-voltage distribution up to half wave patch antenna. The Planar Inverted-F Antenna is mainly used because it has a low profile and an omnidirectional pattern.

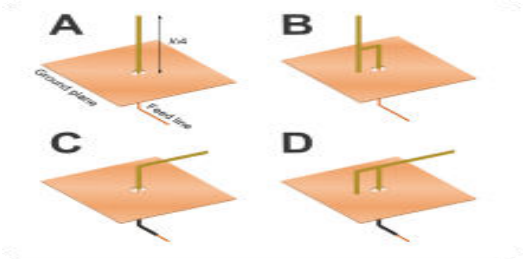

Fig. 2 Shorting pins.

The feed is connected to the intermediate point along with the length of the antenna and base is connected to the ground plane so we have advantages that is the input impedance of antenna is dependent on distance of feed point from ground plane. The impedance of the antenna should be match to the feedline. In this the resonant frequency approximately given as

$f0=C/4(w+b)\sqrt{(\varepsilon_r)}\ ^2$

where;

f_0 is the resonant frequency

w, b are the width and breadth of the patch

c is the speed of light

ε_r is the dielectric constant of the substrate.

The inverted F antenna have narrow bandwidth which is achieved by the length of antenna it increases the radiation resistance.

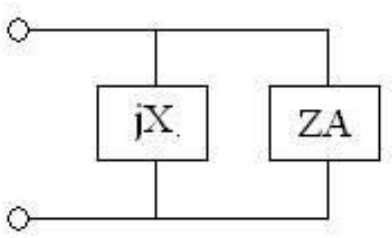

Fig. 3 Equivalent circuit of antenna

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Effect of parallel inductance shifts resonant frequency of the antenna this parallel component produces the admittances (Y=1/Z) adding of 1/(jX) like this the resonant frequency will be alerted.

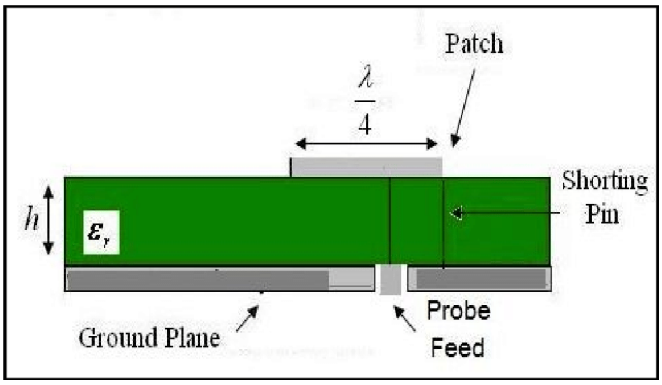

Fig. 4 PIFA with shorting planar

Above figure4 shows that the length L1, and width L2. The feed point shows the distance of D from shorting pin and has height of h to the ground plane. The impedance is controlled by the distance of shorting pins, as impedance decreases and increases and it can be tuned with impedance parameters.

The length of resonant frequency depends on W is W=L2. The width will be maximum when radiation efficiency is

$$W = L2 \Rightarrow L1 = \lambda/4$$

$$if\ W = 0 \Rightarrow L1 + L2 = \frac{\lambda}{4}$$

Assume W<<L2 then resonant frequency is

The resonant length of the PIFA is

$$L1 + L2 - W = \lambda/4$$

$$0.1 + 0.05 - 0.02 = \frac{c}{4f\sqrt{\varepsilon_r}}$$

$$0.13 = \frac{3\times10^8}{4f\sqrt{4}} \Rightarrow f = \frac{3\times10^8}{4\sqrt{4}(0.13)} = 288.5MHZ$$

$$c = \lambda f \quad f = \frac{Co}{\lambda\sqrt{\varepsilon_r}}$$

$$= \frac{3\times10^8}{\lambda\sqrt{\varepsilon_r}}$$

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FLOW CHART:

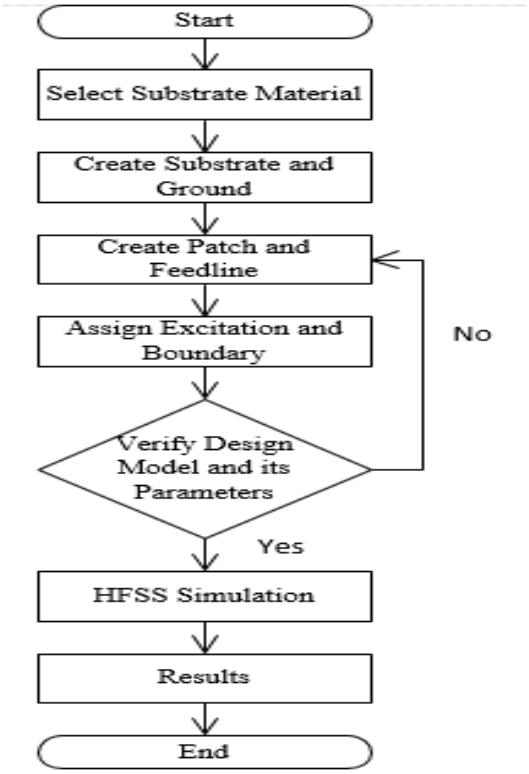

Fig.5 Steps to design PIFA antenna

By using the HIGH FREQUENCY STRUCTER SIMULATOR (HFSS) we going to design the Planar inverted F antenna PIFA. Open the HFSS software then start selecting components required i.e., select the ground plane with the length of X=42, Y=20 and Z=0, then next create Substrate with X=42, Y=20 and Z=0.8, Now create patch antenna and feed line with dimensions of X=18× $18mm$, Z=3.8mm and select YZ plane Y=5.8mm and Z=3.8mm.

For perfect E ground we need to create a rectangle, cover lines and then create a patch by creating a rectangle, coverlines and unite rectangle. Take a sheet with lumped port and create circle and cover lines. Create an outer cylinder we need to take Teflon (tm) material with evaluated values of 6mm,6mm, -10mm with radius of 2.2mm, height=10mm. inner cylinder with evaluated values of 6mm,6mm, -10mm with radius of 0.6mm, height=10mm and for creating feed line the evaluated values are 6mm,6mm,0mm with radius of 0.6mm, height=3.8mm. we need to select air and give radiation box as well as should assign the boundary values i.e.; position=-50mm, -40mm, X=100mm, Y=80mm, Z =60mm. after giving all dimensions and the values we need to verify the model and the parameters then do the simulation find out the result end.

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IV. RESULTS AND DISCUSSIONS

PIFA has three-dimensional antenna pattern,Above figure(7) show the design of Planar inverted F antenna with a radiating pattern.

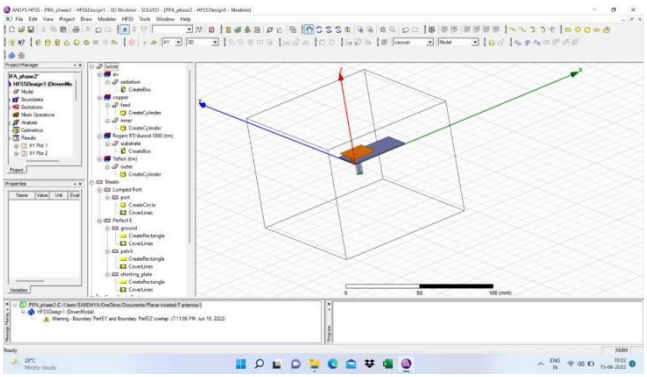

Fig6: Output design of PIFA antenna

Scattering parameter or S-parameter (the element of a scattering matrix or S-matrix) describe the electrical behaviour of linear electrical networks when undergoing various steady state simulate by electrical signal. Scattering refers to the way travelling currents or voltage are affected when they meet a discontinuity in a transmission line.

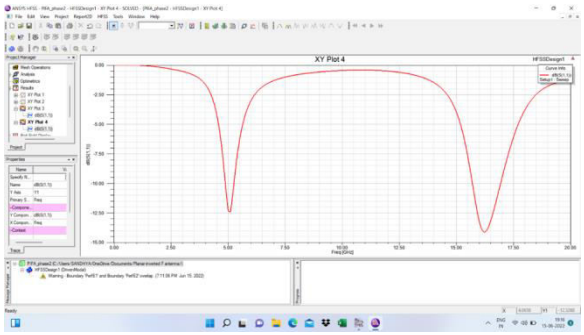

Fig7:S-parameter output

V. CONCLUSION

In this paper, the planar inverted F antenna technology and can find some importance of the PIFA technology and design. So many applications can be found in the usage of PIFA.For better scope using PIFA in better comparison of gain improvement, good radiation pattern, this is one of the low-profile antennas considering with the SAR values, as an array element. PIFA has a strong foundation for 5G mobile communication systems. PIFA is mostly designed in dual band frequencies, it covers a wide range of wireless services. At a particular frequency we can design antennas with required values and radiation pattern.

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