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Performance Analysis of Different Feeding Techniques

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***Abstract*—This paper describes the performance analysis of various feeding approach for wireless microstrip patch antenna i.e for IMT (3G) applications. In this paper, four forms of feeding techniques (Microstrip line feed, coaxial probe feed, proximity coupled feed and aperture coupled feed) are used. From the four feeding techniques, microstrip line and coaxial probe feeds are contacting schemes, in which RF power is fed immediately to the radiating patch the use of a connecting detail along with a microstrip line whereas proximity and aperture coupled feeds are non-contacting schemes, in which electromagnetic discipline coupling is carried out to transfer power among the microstrip line and the radiating patch. This work describes four feeding strategies and gives a higher understanding of design parameters of an antenna and their impact on go back losses, bandwidth, VSWR and resonant frequency.**

***Index Terms*— Microstrip patch antenna, microstrip feed, coaxial probe feed, proximity coupled feed, aperture coupled feed, go back loss, bandwidth, VSWR, resonant frequency, HFSS.I. advent.**

I. INTRODUCTION

Presently wireless verbal exchange, by means of measure is the quickest developing section of the communiqué subject. There are numerous authorities and business programs such as cellular radio, satellite communique and wireless verbal exchange in which weight, length, cost, performance, ease of set up, aerodynamics profile are primary constraints. The vision of the wireless communiqué helping facts change among humans and gadgets is the verbal exchange frontier of the following few a long time. This imaginative and prescient will allow multimedia communication from anywhere within the world. Almost all of the crucial wireless packages lie in the band beginning from 900 MHz to 5.8 GHz.

International mobile Telecommunications (IMT) generation is maximum rapidly growing vicinity within the current wireless communiqué. This offers users the mobility to move around within a large coverage location and nonetheless be related to the network. This affords substantially extended freedom and versatility. For the house consumer, wireless has come to be famous because of ease of set up, and place freedom. So, there's constantly increasing necessities of efficient and excessive overall performance antenna.

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This technique has been broadly diagnosed as a viable, fee-powerful and high-pace facts connectivity solution, permitting person mobility. In practice, IEEE 802.11 IMT standards include 3.8-GHz (3.4–4.2 GHz) and a pair of 3.5-GHz (2.3–2.4 GHz) frequency bands [7].

II. Studies Historical Past

Microstrip patch antennas can be fed by means of a ramification of methods. Those techniques may be classified into two categories-contacting and non-contacting. Within the contacting method, the RF electricity is fed without delay to the radiating patch using a connecting detail which includes a microstrip line. Within the non-contacting scheme, electromagnetic area coupling is executed to transfer power between the microstrip line and the radiating patch. The four maximum famous feed strategies used are the microstrip line, coaxial probe (each contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes) [6].

A. Microstrip Line Feed

On this form of feed approach, an accomplishing strip is attached at once to the threshold of the Microstrip patch. The conducting strip is smaller in width as compared to the patch and this type of feed association has the advantage that the feed can be etched at the identical substrate to offer a planar shape.
However as the thickness of the dielectric substrate being used, increases, floor waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation additionally ends in undesired cross polarized radiation. This technique is fantastic because of its simple planar shape [1, 6].

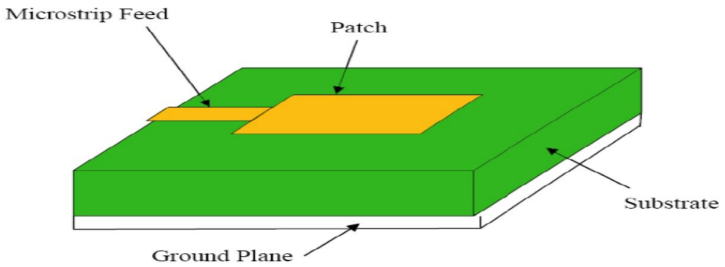

Figure 1. Microstrip Line Feed[1]

B. Coaxial Probe Feed

The Coaxial feed or probe feed is a completely common approach used for feeding Microstrip patch antennas. The inner conductor of the coaxial connector extends via the dielectric and is soldered to the radiating patch, even as the outer conductor is attached to the ground aircraft. The primary benefit of this type of feeding scheme is that the feed can be positioned at any preferred place within the patch so one can suit with its enter impedance. However, its major drawback is that it presents slim bandwidth and is hard to model considering that a hole needs to be drilled inside the substrate and the connector protrudes outside the ground plane, consequently now not making it absolutely planar for thick substrates [1, 6].also, for thicker substrates, the extended probe period makes the enter impedance extra inductive, leading to matching problems. It's far visible above that for a thick dielectric substrate, which provides vast bandwidth; the microstrip line feed and the coaxial feed suffer from numerous dangers. To be able to reduce those forms of dangers, we are able to observe non-contacting schemes [8].

C. Proximity Coupled Feed

This type of feed technique is also called as the electromagnetic coupling scheme. Two dielectric substrates are used such that the feed line is between the two substrates and the radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides very high bandwidth (as high as 13%) due to overall increase in the thickness of the microstrip patch antenna. This scheme also provides choices between two different dielectric media, one for the patch and one for the feed line to optimize the individual performances [11].
This method is advantageous to reduce harmonic radiation of microstrip patch antenna implemented in a multilayer substrate. The goal of the design is the suppression of the resonances at the 2nd and 3rd harmonic

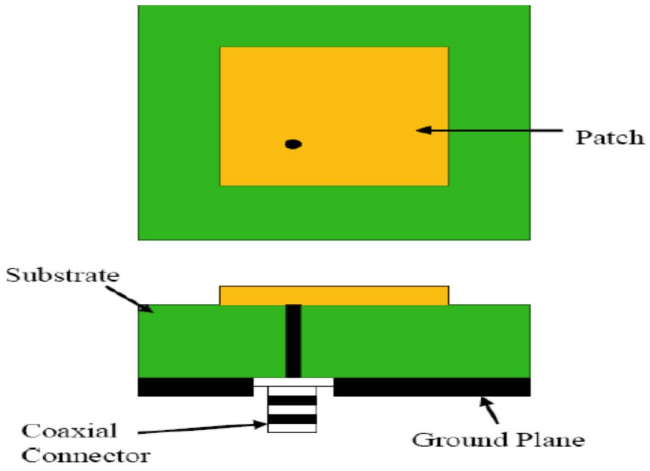

Figure 2. Coaxial probe Feed[1]

frequencies to reduce spurious radiation due to the corresponding patch modes to avoid the radiation of harmonic signals generated by non-linear devices at the amplifying stage. The study shows the possibility of controlling the second harmonic resonance matching by varying the length of the feeding line. On the other hand, the suppression of the third harmonic is achieved by using a compact resonator [14].

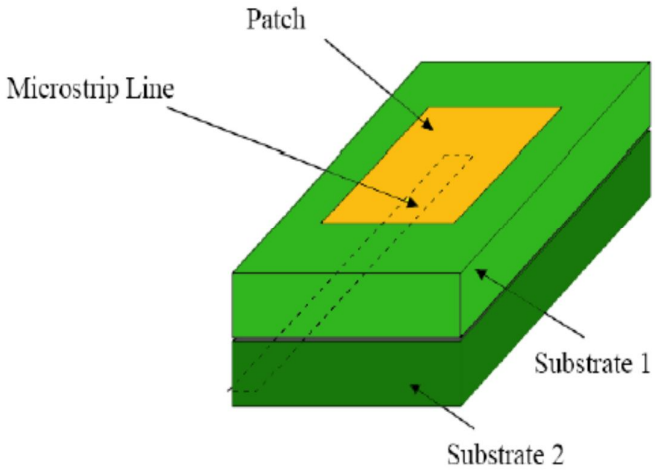

Figure 3. Proximity coupled Feed [1]

D. Aperture Coupled Feed

On this sort of feed technique, the radiating patch and the microstrip feed line are separated with the aid of the floor aircraft. Coupling among the patch and the feed line is made thru a slot or an aperture inside the floor aircraft and variations inside the coupling will rely on the dimensions i.e. period and width of the aperture to optimize the result for wider bandwidths and better return losses. The coupling aperture is commonly cantered under the patch, leading to lower pass-polarization due to symmetry of the configuration. Because the ground aircraft separates the patch and the feed line, spurious radiation is minimized [16].Aperture coupled feeding is attractive because of advantages which include no bodily touch among the feed and radiator, wider bandwidths, and better isolation between antennas and the feed network. Moreover, aperture-coupled feeding allows impartial optimization of antennas and feed networks through using substrates of different thickness or permittivity [17].

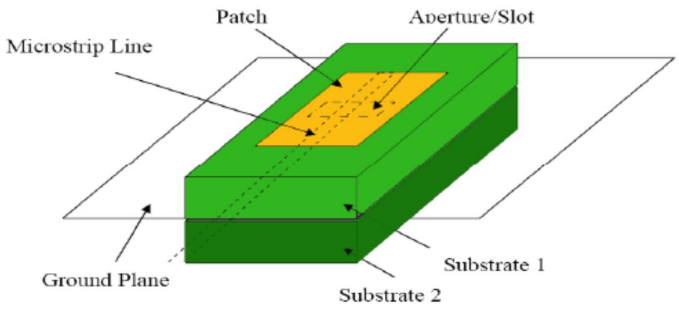

Figure 4. Aperture coupled Feed [1]

III. Proposed Approach

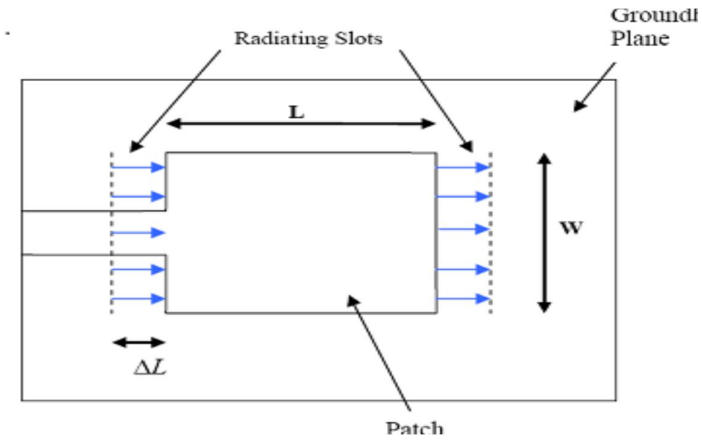

Figure 5. Microstrip Patch Geometry

Discern five suggests the basic microstrip patch geometry. The duration of the patch is denoted by using L and width of the patch is denoted with the aid of W. due to the fact the scale of the patch are finite alongside the duration and width, the fields at the rims of the patch go through fringing. In view that some of the waves journey in the substrate and some in air, an powerful dielectric steady is added to account for fringing and the wave propagation inside the line.

The size the patch alongside its duration has been extended by way of a distance ΔL because of the fringing field that's a characteristic of effective dielectric regular. Consequently the effective duration is extended by means of 2ΔL as proven. Peak (h) for proposed layout as per research paper could be 1.6 mm. various formulation for designing a microstrip patch antenna are written below [2, 9].

Calculation of effective dielectric steady, εreff, which is given by means of:

$$\varepsilon_{reff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Calculation of the duration extension L, which is given by:

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

For green radiation, the width W is:

$$W = \frac{c_0}{2f_o\sqrt{(\epsilon_r+1)/2}}$$

Now to calculate the length of patch turns into: $L = L_{eff} - 2\Delta L$

Where the effective period of the patch Leff is: $L_{eff} = \frac{\lambda_0}{2\sqrt{\epsilon_{reff}}}$

Length and width of the ground $L_g = 6h + L$

$W_g = 6h + W$

By using special feeding techniques (proximity or aperture coupling) and stacked patches, bandwidth of over 50% has been done. but, such configurations cause a larger antenna length. so as to design a compact Microstrip patch antenna, diverse efforts were made by means of researchers all over the world to enhance the bandwidth of a patch antenna [1, 2].

A. Fringing Effect

Because of dimension of the patch are finite along the length and width, the fields along the edges of the patch undergo fringing. Most of the electric field lines reside in the substrate and parts of some lines in air. As a result, this transmission line cannot support pure transverse electric- magnetic (TEM) mode of transmission, since the phase velocities would be different in the air and the substrate. Hence, an effective dielectric constant must be obtained in order to account for the fringing and the wave propagation in the line as shown in figure. The value of effective permittivity is slightly less than permittivity of dielectric substrate because the fringing fields around the periphery of the patch are not confined in the dielectric substrate but are also spread in the air. The fringing fields along the width can be modelled as radiating slots and electrically the patch of the microstrip antenna looks greater than its physical dimensions [1, 5].

IV. Software Used

HFSS: high Frequency structure Simulator (HFSS) is an excessive performance complete wave electromagnetic (EM) discipline simulator for arbitrary 3-D volumetric passive tool modelling that takes benefit of the familiar Microsoft windows graphical consumer interface. Ansoft HFSS may be used to calculate parameters which include S-Parameters, Resonant Frequency and Fields.

HFSS makes use of a 3D full-wave Finite element approach (FEM) to compute the electrical conduct of excessive-frequency and excessive-pace additives. With HFSS, engineers can extract parasitic parameters (S, Y and Z), visualize three-D electromagnetic fields (near- and far-area), and generate full-Wave SPICE™ fashions to efficiently examine sign high-quality, which includes transmission path losses, mirrored image loss because of impedance mismatches, parasitic coupling, and radiation.

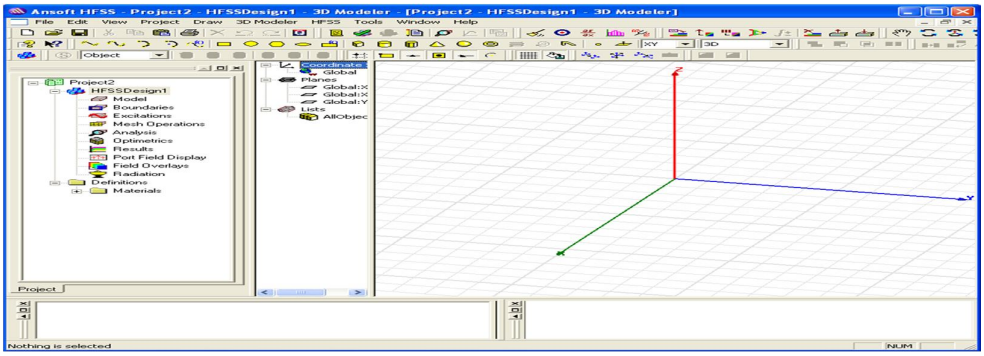

Figure 6. HFSS-3D WINDOW

V. Conclusion

Eventually, the top-rated end result of all four feeding techniques of square patch antenna on FR4 and Duroid substrate for wi-fi 3G packages is investigated. A comparison is made among feeding strategies in phrases of bandwidth, go back loss, VSWR and patch size and smith chart. So, we can see that choice of the feeding method for a microstrip patch antenna is a crucial selection as it influences the bandwidth and other parameters also. A microstrip patch antenna excited with the aid of one of a kind excitation strategy gives distinct bandwidth, special advantage, specific performance and so on.

The maximum bandwidth may be done by means of aperture coupling. Proximity coupling gives the exceptional impedance matching and radiation efficiency. Coaxial feeding method offers the least bandwidth. We also can conclude that by means of changing the feed point where matching is best, the high go back loss can be completed on the resonant frequency. Numerous microstrip patch antennas with every extraordinary feeding method are supplied. The various parameters like go back loss, radiation pattern, smith chart, electric subject and VSWR might be plotted for each antenna. The overall performance homes could be analyzed for the optimized dimensions and the proposed antenna works well at the desired (3.4- 3.8) GHz IMT frequency band.

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