© March 2019 | IJIRT | Volume 5 Issue 10 | ISSN: 2349-6002

Simulation of Rectangular Microstrip Antenna Using HFSS Software

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Abstract- **Due to the existence of growth in development of low cost, less weight, highly reliable, minimal profile antennas for wireless devices, it poses a new challenge for the design of antenna in wireless communications. This paper presents simulation of a rectangular micro strip patch antenna at 19 GHz for wireless communications that provides a radiation pattern along a wide angle of beam and achieves a gain of 10dBi.The rectangular micro strip patch antenna was analyzed using Ansoft HFSS and also made a comparison among the different substrates which shows different results based on same parameters.**

Index Terms- Microstrip patch antenna, Frequency, Gain, Beam width, HFSS, Wireless communication.

I. INTRODUCTION

An antenna is an electrical conductor or a system of conductors which is "that part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves". A Microstrip antenna consists of a thin metallic conductor which is bonded to thin grounded dielectric substrates. Microstrip patch antenna used to send onboard parameters of article to the ground while under operating conditions. The aim of the thesis is to design and fabricate an inset-fed rectangular Microstrip Patch Antenna and study the effect of antenna dimensions Length (L), Width (W) and substrate parameter relative Dielectric constant(εr), substrate thickness(t) on the Radiation parameters of Bandwidth and Beam-width. The size miniaturization of Microstrip patch antenna is crucial in many of the modern day practi1cal applications, like that of Wireless local area networks(WLAN's), mobile cellular handsets, global position satellites (GPS) and other upcoming wireless terminals. Patch antennas play a very significant role in today's world of wireless communication systems.

II.RECTANGULAR MICROSTRIP ANTENNA

A. Antenna shape

Microstrip patch antenna has a ground plane on the one side of a dielectric substrate which other side has a radiating patch as shown in Fig.(1) A rectangular patch is used as the main radiator. The patch is generally made of conducting material such as copper or gold and can take any possible shape. Dielectric constant of the substrate (ϵr) is typically in the range 2.2<ϵr<12.

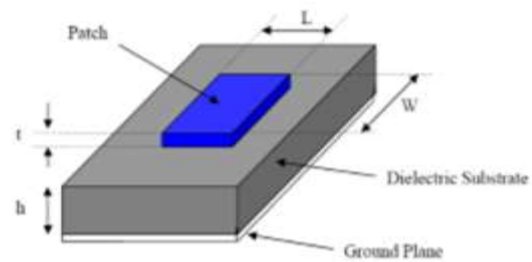

Fig (1) Microstrip antenna

For good antenna performance, a low dielectric constant with thick dielectric substrate is desirable, as it provides better radiation, better efficiency and larger bandwidth

B. Analyzing method

Transmission line model depicts the microstrip antenna by two slots of width W and height h separated by transmission line of length L. The microstrip is a non-homogeneous of two dielectrics typically substrate and the air. Most of the electric field lines reside some part in the air and rest in the substrate. This results that transmission line does not support transverse electric-magnetic (TEM) mode of transmission, as phase velocities would be different in substrate and in the air. So dominant mode of propagation will be the quasi-TEM mode. An effective dielectric constant (ϵreff) must be obtained to account for wave propagation in the line and fringing. The value of ϵreff must be smaller than ϵr, as fringing fields across patch periphery was not totally included in the substrate ,it also spread in the air as shown in Fig(2) below.

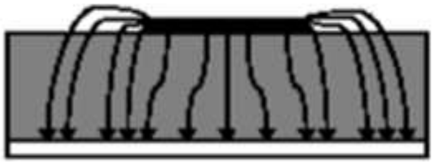

Fig (2) Electric field lines

To design the patch antenna, following things has to be determined ϵreff= Effective dielectric constant ϵr = Dielectric constant of substrate h = Height of dielectric substrate W = Width of the patch L = Length of the patch Assume Fig (3), a rectangular microstrip antenna of width W, length L resting on the height of a substrate h. The coordinate axis was selected as the height along z direction, length along x direction and width along y direction.

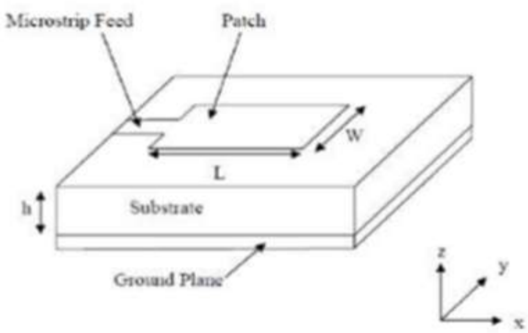

Fig (3) Microstrip patch antenna

In order to operate in the fundamental mode, length of the patch should be slightly less than λ/2, where λ is the wavelength. The TM10 implies that field varies a cycle of λ/2 along the length, and width of the patch has no variation.

The microstrip patch antenna is represented by two slots, separated by a transmission line of length L and open circuited at both the ends as shown in Fig(4)

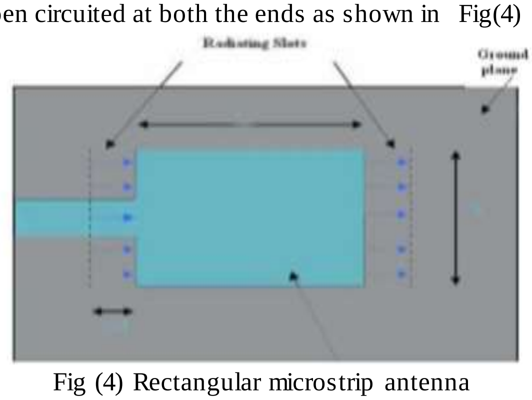

Fig (4) Rectangular microstrip antenna

The voltage is maximum along the width of the patch and due to the open ends, the current is minimum. With respect to the ground plane the fields at the edges can be resolved into tangential and normal components.

The normal components of the electric field at the two edges along the width are in opposite directions and thus out of phase as seen in Fig (5). Since the patch is λ/2 long and hence they cancel each other in the broadside direction. The tangential components which are in phase, means that the resulting fields combine to give maximum radiated field normal to the surface of the structure. Hence the edges along the width can be represented as two radiating slots, which are λ/2 apart and excited in phase and radiating in the half space above the ground plane. The fringing fields along the width can be modeled as radiating slots and electrically the patch of the microstrip antenna looks greater than its physical dimensions. The dimensions of the patch along its length have now been extended on each end by a distance ΔL.

III. SIMULATION OF HFSS SOFTWARE

In that paper this antenna is simulate and obtain result on High frequency Simulation Software (HFSS) Version-13. The fig 5. shows the simulation steps of HFSS and it create 3-D object.

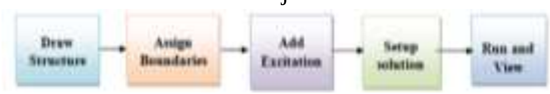

Fig (5) simulation flow chart steps of HFSS

Draw Structure: In that structure first take a one substrate and also assign material to that substrate (FR4 Epoxy) and then draw a sheep of antenna by using rectangular, circular or triangle sheep. In a base of antenna draw a one box named as ground. At the end of antenna draw a two cylinder name as clad and core. Assign material to clad that is air material and core that is Perfect conductor material. Finally draw a one air box and insert antenna.

Assign Boundaries: Antenna simulation in HFSS Perfect E Boundaries represents a perfectly conducting surface. In that antenna the conducting surface is as shown in fig (a). Assign Perfect Radiation to air box because of it Represents an open boundaries by means of an absorbing boundaries condition (ABC) that absorbs outgoing waves.

Add Excitation: Excitations in HFSS is used to specify the sources of electromagnetic fields, charges, currents, or voltages on objects or surfaces in the design. In that antenna assign a wave port as an excitation because it represents the surface through which a signal enters or exits the geometry.

Setup solution: It is Specify how HFSS will compute a solution by adding a solution setup to the design. We can define more than one solution setup per design. Each solution setup consist of general data about the antenna that is solution frequency (19GHz), maximum number of passes (20) and value of delta (0.02).

Run and View Result: After the completion of all designing part, check the designing antenna validity. If it is correct then go to analysis all. To use this command, either click HFSS>Analyze All or right-click on the Analysis icon in the Project tree and select Analyze All from the popup menu. The Analyze All command applies to all enabled setups, dependent setups, and sweeps at the level invoked in the Project tree.

IV. ADVANTAGES

Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low-profile structure. The telemetry and communication antennas on missiles need to be thin and conformal and are often in the form of Microstrip patch antennas. Another area where they have been used successfully is in Satellite communication.

- Light weight and low volume
- Low profile planar configuration which can be easily made conformal to host surface.
- Low fabrication cost, hence can be manufactured in large quantities.
- Supports both, linear as well as circular polarization.
- Can be easily integrated with microwave integrated circuits (MICs).
- Capable of dual and triple frequency operations.
- Mechanically robust when mounted on rigid surfaces.

V.APPLICATION

The Microstrip patch antennas are well known for their performance and their robust design, fabrication and their extent usage. The advantages of this Microstrip patch antenna are to overcome their de-merits such as easy to design, light weight etc., the applications are in the various fields such as in the medical applications, satellites and of course even in the military systems just like in the rockets, aircrafts missiles etc. the usage of the Microstrip antennas are spreading widely in all the fields and areas and now they are booming in the commercial aspects due to their low cost of the substrate material and the fabrication. It is also expected that due to the increasing usage of the patch antennas in the wide range this could take over the usage of the conventional antennas for the maximum applications. Microstrip patch antenna has several applications. Some of these applications are discussed as below:

Mobile and satellite communication application: Mobile communication requires small, low-cost, low profile antennas. Microstrip patch antenna meets all requirements and various types of microstrip antennas have been designed for use in mobile communication systems. In case of satellite communication circularly polarized radiation patterns are required and can be realized using either square or circular patch with one or two feed points.

Global Positioning System applications: Nowadays microstrip patch antennas with substrate having high permittivity sintered material are used for global positioning system. These antennas are circularly polarized, very compact and quite expensive due to its positioning. It is expected that millions of GPS receivers will be used by the general population for land vehicles, aircraft and maritime vessels to find their position accurately

Radio Frequency Identification (RFID): RFID uses in different areas like mobile communication, logistics, manufacturing, transportation and health care. RFID system generally uses frequencies between 30 Hz and 5.8 GHz depending on its applications. Basically RFID system is a tag or transponder and a transceiver or reader.

Worldwide Interoperability for Microwave Access (WiMax): The IEEE 802.16 standard is known as WiMax. It can reach up to 30 mile radius theoretically and data rate 70 Mbps. MPA generates three resonant modes at 2.7, 3.3 and 5.3 GHz and can, therefore, be used in WiMax compliant communication equipment.

Radar Application: Radar can be used for detecting moving targets such as people and vehicles. It demands a low profile, light weight antenna subsystem, the microstrip antennas are an ideal choice. The fabrication technology based on photolithography enables the bulk production of microstrip antenna with repeatable performance at a lower cost in a lesser time frame as compared to the conventional antennas.

Telemedicine Application: In telemedicine application antenna is operating at 2.45 GHz. Wearable microstrip antenna is suitable for Wireless Body Area Network (WBAN). The proposed antenna achieved a higher gain and front to back ratio compared to the other antennas, in addition to the semi directional radiation pattern which is preferred over the Omni-directional pattern to overcome unnecessary radiation to the user's body and satisfies the requirement for on-body and off-body applications. A antenna having gain of 6.7 dB and a F/B ratio of 11.7 dB and resonates at 2.45GHz is suitable for telemedicine applications.

VI. CONCLUSION

The Broadband K band patch antenna has the advantage over all the antenna is that, it has the less return loss, i.e. 10-dB. Omni directional radiation pattern, It is because the symmetrical configuration of the T-shape slot antenna, and it has a peak antenna gain of about 4.8 dB, with gain variations less than 3 dB across the operating bandwidth from 18 GHz to 27 GHz. In addition to the advantages of low cost, simple structure, and wide operating band, the Patch antennas has nearly Omni directional radiation for all operating bands including PCS, 3G, Bluetooth, DMB and WANL and gain variation of the range in each of the bands can be less than 3 dB

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