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Patch Antenna Designing using Substrate Integrated Circuit

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Abstract- *A patch antenna based on Substrate Integrated Circuits (SIC) technology, has been designed at 2.4 GHz and its response has been determined between frequency range of 2-3GHz. SIC is a new generation integrated circuit(IC) offering a compact, cost-effective and performance enhancing solution for mass commercial applications with monolithic high density 3D-integration of planar and non-planar structures. This paper presents an overview of how a simple patch antenna operating at 2.4 GHz frequency is designed using FV substrate coupled with the parametric simulations.*

Keywords : Substrate, SIC, patch antenna,s-parameters, ADS.

I. INTRODUCTION

Rigid Waveguides and three dimensional structures used to send a single dimensional signal was the first seed in the development of microwave engineering. This was termed as the first generation of microwave development. The second generation was the Microwave integrated circuits (MIC) without any active components. Miniature MIC (MMIC) with the addition of lumped active elements was the third generation. The next level was Multilayered MMIC , MEMS and RFIC devices It was the most significant development. Furthermore, with the arrival and exploratory development of **Substrate Integrated Circuits (SIC) technology,** we are starting a new "voyage" of discovery.

Substrate:

A solid substance or medium to which another substance is applied such that the second substance adheres to it is called a substrate. In the manufacture of an IC, the substrate material is cut or formed into thin discs called wafers, on which the individual electronic components are etched, deposited or fabricated.

Patch Antenna:

Antenna is a transducer designed to transmit or receive electromagnetic waves. A patch antenna is also known as a rectangular microstrip antenna which can be mounted on a flat surface. In the current design, the flat surface on which it is mounted is the FV substrate.

The advantages of this Microstrip patch antennas are that they are easy to design, light weight and comparatively cheaper than other antennas. A Patch antenna finds applications in various fields such as medical sector, satellites and even in military systems e.g. in the rockets, aircrafts missiles etc. The usage of the Microstrip antennas is 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 fabrication process adopted. In the due course of time,it is also expected that the increasing usage of the patch antennas in almost all applications will take over the usage of the conventional antennas in the time to come.

II. DESIGN AND ANALYSIS

In this research paper , a simple patch antenna has been designed whose operating frequency is 2.4 GHz and its response has been analyzed between 2 GHz and 3 GHz. Figure-1 shows the schematic diagram of patch antenna where P1 is the input port, MLIN is microstrip line and MLOC is micro strip line open circuit. TL1 and TL2 stands for transmission line 1 and transmission line 2 respectively. L gives the length and W gives the width of the components shown in **Figure-1**

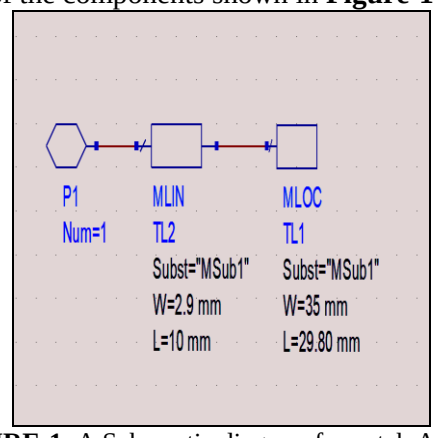

FIGURE-1: A Schematic diagram for patch Antenna designing.

Patch antenna is designed using s (scattering) parameters for two ports network. Scattering parameters shows the electrical behaviour of networks.

Two port s- parameters have following description:

S_{11} is the input port voltage reflection coefficient

S_{12} is the reverse voltage gain

S_{21} is the forward voltage gain

S_{22} is the output port voltage reflection coefficient

III.APPLICATIONS

Microstrip patch antenna has several applications such as:

1.Mobile and satellite communication :

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.

2.Global Positioning System:

Microstrip patch antennas with substrate having high permittivity material are used for global positioning system.

3.Telemedicine:

In telemedicine application antenna is operating at 2.45 GHz.

4.Radar:

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.

5. Medicine:

It is found that in the treatment of malignant tumors the microwave energy is said to be the most effective way of inducing hyperthermia. The design of the particular radiator which is to be used for this purpose should posses light weight, easy in handling and to be rugged. Only the patch radiator fulfils these requirements.

IV.SIMULATION

For designing of the patch antenna, first the microstrip line is synthesized using following values:

ε_r= 4.3, H=1.5 mm, T=20 um, tanD= 0.003,

f=2.4 GHz, W=2.9 mm and L=10mm

STEP-1: After synthesis of microstrip line schematic diagram shown in FIGURE-1 is developed on the schematic window of the ADS software which gives the antenna layout design as shown in **FIGURE-2.**

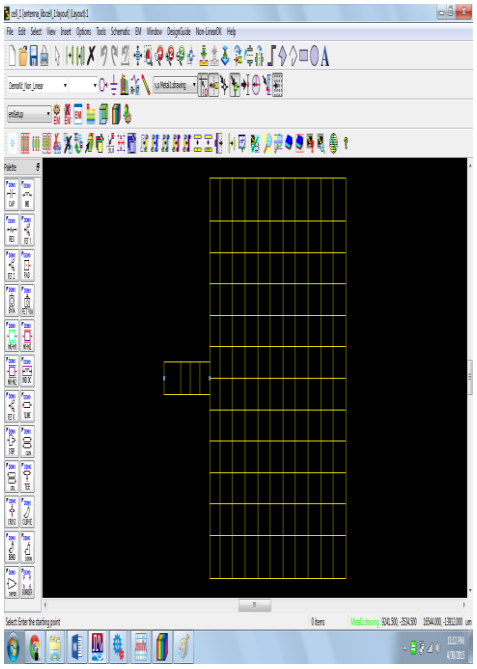

FIGURE-2:Layout of a Patch Antenna on ADS software tool.

STEP-2: After obtaining the 2D layout of patch antenna the substrate which we named “FV” has been designed with dielectric constant 4.3 F/m and thickness 1.5 mm as shown below in FIGURE-3

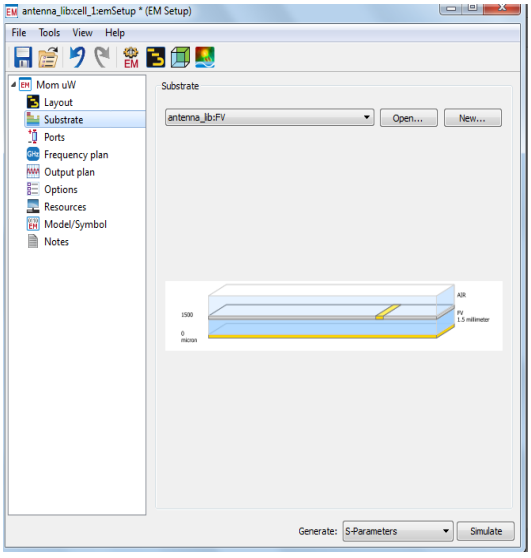

FIGURE-2:Substrate

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STEP-2: The start and stop frequency has been set as 2 GHz and 3 GHz respectively for the simulation of the designed antenna. After simulating the circuit shown in fig. 1 we get the results as shown in FIGURE-4

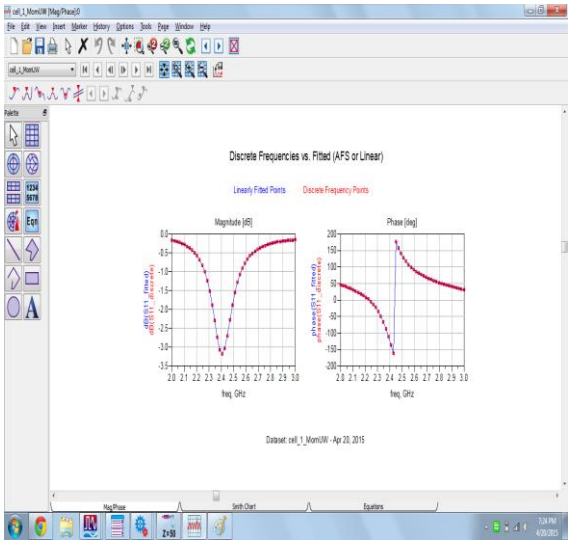

FIGURE-4: Simulation results

The graph obtained is between frequency (x-axis) and loss (negative y axis). The operating frequency is 2.4 GHz at which a dip is seen. This dip shows that at 2.4 GHz frequency minimum antenna loss takes place. Minimum antenna loss means maximum transfer, so at 2.4 GHz frequency which is the operating frequency maximum transfer is obtained.

STEP-3: After simulation curve 3D structure of antenna has been obtained which is shown in FIGURE-5 below.

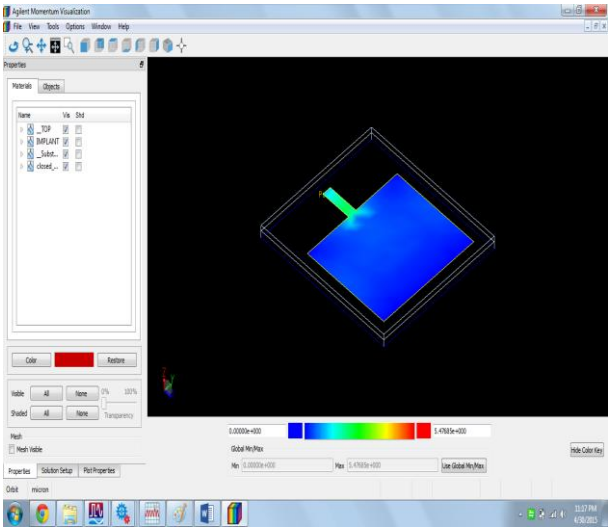

FIGURE-5: Simulated 3D structure of Antenna

STEP-4: At different frequencies different radiation intensity is observed, maximum being at 2.4 GHz as shown in FIGURE-6

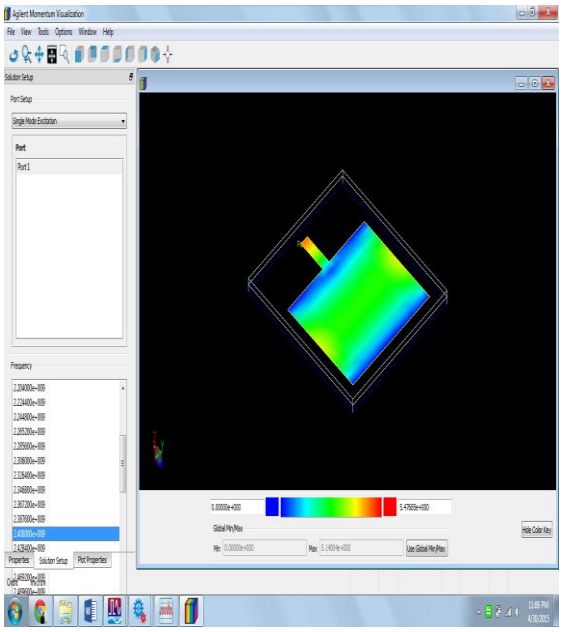

FIGURE-6 Maximum radiation at 2.4 GHz frequency

STEP-5: 3D radiation pattern with radiated power equal to 0.00184222 watts has now been obtained as shown in FIGURE-7 below:

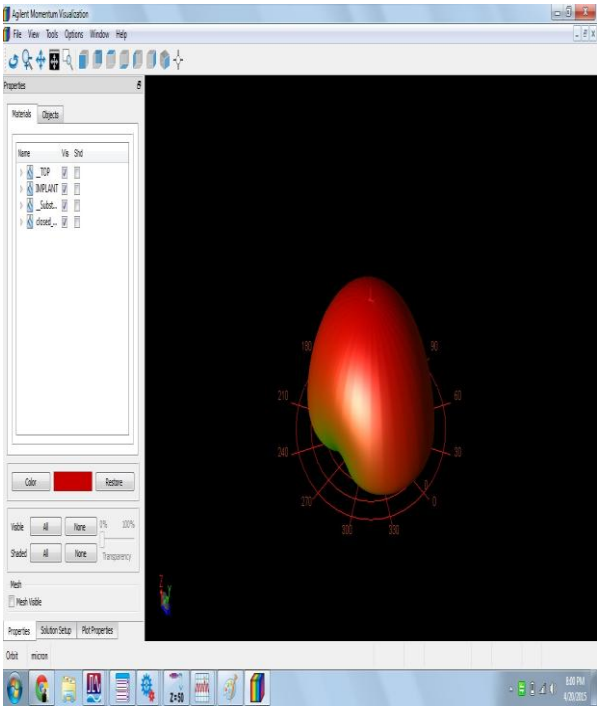

FIGURE-7: 3D radiation pattern of patch antenna.

V.CONCLUSION

In this paper a patch antenna operating at 2.4 GHz frequency has been designed using ADS (Advanced Design System) software and its response has been analysed between 2 GHz and 3 GHz frequencies. Antenna designing has been done on substrate which we named "**FV**" of dielectric constant 4.3 F/m.

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