

ANALYSIS FOR DESIGNING A MICROSTRIP PATCH ANTENNA AT 2.4 GHz

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Abstract: Antenna is used for transmission and reception of radio signals. It plays vital role in communication system. In this Paper, microstrip patch antenna is used for wireless communications to provide high Bandwidth, Efficiency, and Gain. Microstrip antenna are also Known as patch antennas or printed antennas or planar antennas. The Proposed of this paper is to design microstrip patch antenna at resonant frequency 2.4GHz.

Index Terms - HFSS (High-Frequency Structure Simulator), Dielectric (FR4), Rectangular patch, DGS (U-shape), Co-axial feeding technique

I. INTRODUCTION

As communications is growing day by day the need of portable devices which can be carried everywhere is also been increasing. To make the communication device easily portable and light weight the microstrip antenna plays an important role. Our main aim is to design microstrip antenna which is of 2.4 GHz frequency (ISM Bands) which is free unlicensed band. This 2.4 GHz frequency band which we are using can be used by any device for any application without any restriction. The great advantage of this antenna is it is thin and easy to manufacture. Patch antennas are planar antenna used in wireless links and other microwave applications. The Drawback of MPA, it has narrow bandwidth and for practical application bandwidth enhancement is necessary, so for extending the bandwidth many approaches have been utilized. The Proposed of this paper is to design an antenna which overcomes disadvantages.

The different multiband techniques studied for converting Single band to multiple bands are U, E and H patch over the substrate. The E-shaped patch antenna provides highest bandwidth followed by U-shaped patch antenna and H shaped patch antenna. E slot is used when the frequencies chosen are from different bands. But in this project, the frequencies for the proposed antenna are close together. E slot is formed by using 2 U-slots; hence it can lead to overlapping of the U slots which can cause wrong radiation patterns. U slots can also be designed to perform a number of functions including wideband, dual-and triple-band operations with small and large frequency ratios, as well as for circular-polarization applications. Though with reduction in the size of rectangular patch resulting is asymmetric with U-slot patch antenna fed with thicker probe, broadening the operating bandwidth is possible.

II. LITERATURE SURVEY

Wireless technologies have the main advantage of mobility and simplicity due to which people move towards them. Antennas are main backbone of wireless technology. But antennas which are of small size and low cost are more desirable. Therefore the demand for Microstrip antenna is increasingly replacing conventional antenna which is heavy and also being of a big size and they also occupy a lot of space thus adding difficulty to the installation process. As the coin has two sides that way Microstrip antenna also has many advantages but they also has few disadvantages also which are narrow bandwidth, low gain, and low power handling capacity in order to overcome this drawback we need to improve parameters such as gain, bandwidth, radiation pattern, return loss, directivity etc. for which we need to consider the length, width, height, substrate, and dielectrics etc.

Compact size, Low cost, and ease of fabrication are the main advantages of Microstrip antenna. But the main disadvantages of the antenna is impedance, bandwidth. So here the technique S-shaped impedance matching network (IMN) is used. Better impedance matching takes place and also good broadside radiation is observed due to the S-shaped impedance matching network. Also due to this two resonant frequency points bandwidth is enhanced greatly.

The IMN technique has a disadvantage of power loss which will, in turn, reduce the gain of the antenna. To counter this a dielectric layer is added along with parasitic patch with the lower dielectric substrate. This will increase the gain effectively. With slots symmetrically to one of the axis, bandwidth can be enhanced. The feeding arrangement exhibited in the designed model is a coaxial connector in the ground plane with center pin extended to the patch as inductive probe although other feeding methods

could be easily adopted the designed antenna give us bandwidth enhancement of up to 20% at 10 DB return loss. Using the stacked patch effective thickness of Microstrip patch antenna is increased that result in a decrease of effective permittivity.

III. SYSTEM OVERVIEW

Basic structure of microstrip patch antenna

The basic design of the antenna consists of Patch (Radiating Element), Substrate & Ground Plane. The typical range for the dielectric constant of the substrate being used is $2.2 \leq \epsilon_r \leq 12$ these antennas are simple to design, easy to modify according to needs, inexpensive, lightweight. One the other sides these antennas have low bandwidth and low power.

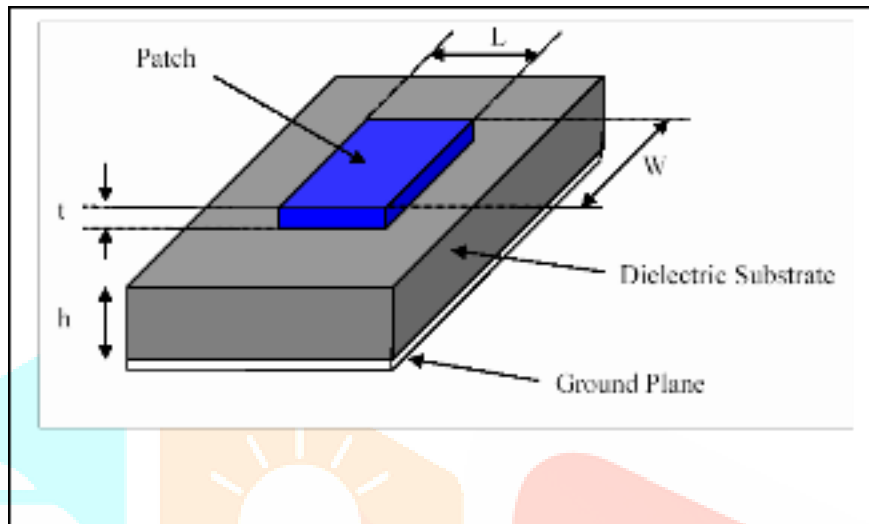
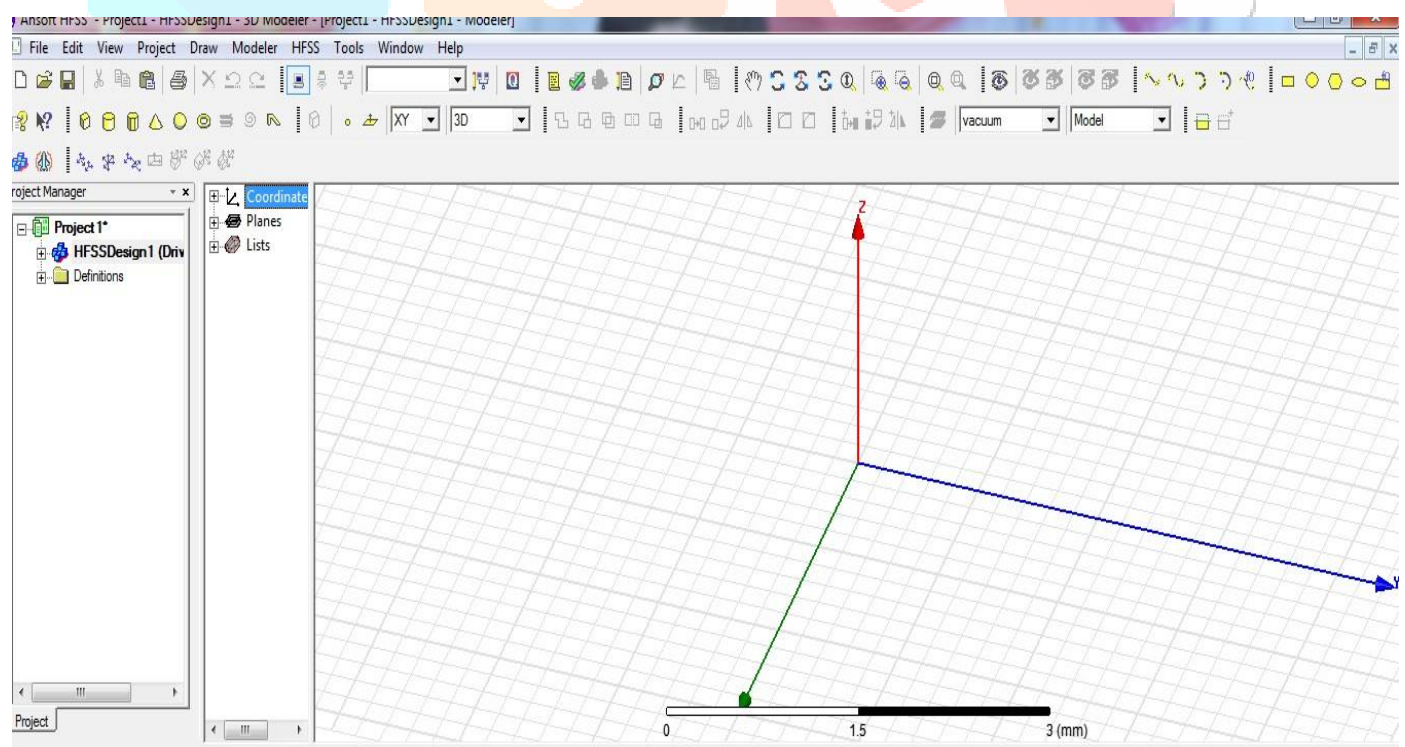


Fig3.1: Structure of microstrip patch antenna

Software Used



HFSS is a high-frequency structure simulator. This is a procedure where a structure is subdivided into many smaller subsections called finite element. Since HFSS was one of the first tools in the market, and also due to its generality and flexibility HFSS is one of the tools heavily used in industrial design environments. The purpose of HFSS is to extract parasitic parameters and visualize 3D electromagnetic fields (near and far field) and generate spice models. All based on a 3D fem of electromagnetic topology under consideration. Very useful features of HFSS are its automatic adaptive mesh generation and refinement, which in most cases frees the designer of worrying about which mesh/grid is to choose. This software is basically used for all kind of antenna purposes. Accurate results for small planar antenna topologies can be found. Input impedance and radiation pattern are generally predicted very well, few results are found about the efficiency.

Feeding Technique

Microstrip antenna can be feed by several of method:-

They are categories into two types:-

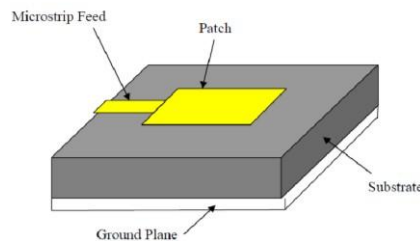
- A. Contacting
- B. Non-Contacting

A. Contacting Method:-

When RF power is directly given to the radiating patch using a connecting element such as Microstrip line is called Contacting Method.

Contacting are further divided into two types:-

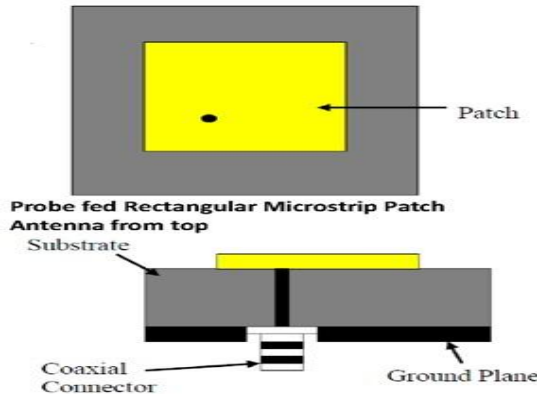
- a. Microstrip Line
- b. Coaxial Probe
 - a. Microstrip Line:-



A conducting strip is connected directly to the edge of the Microstrip patch in microstrip line. As compared to the patch the conducting strip line is smaller in width and this kind of feed arrangement has the advantage that to provide a planar structure the feed can be etched on the same substrate.

Due to the use of thick dielectric substrate increases surface wave and spurious feed radiation also increases which affect the bandwidth of the antenna. Due to its simple planar structure, this method is advantageous.

b. Coaxial Probe:-



Coaxial probe feeding technique is a very common technique used for feeding microstrip patch antenna. In this feeding technique, the outer conductor is connected to the ground plane while the inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch. The feed can be placed at any desired location inside the patch in order to match with its input impedance is the main advantage of these feeding technique.

It provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane is the major drawback of these feeding technique, thus not making it completely planar for thick substrates.

Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems. It is seen in figure that for a thick dielectric substrate, which provides broad bandwidth, the coaxial feed and microstrip feed suffer from numerous disadvantages. So to reduce these types of disadvantages, we will study non-contacting schemes.

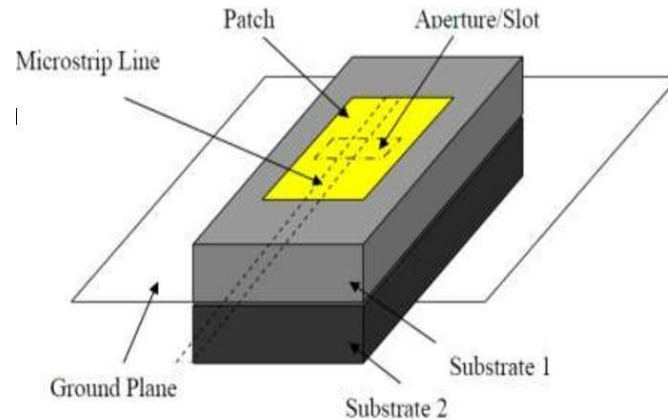
B. Non-Contacting Method:-

To transfer power between the Microstrip line and radiating patch, the electromagnetic coupling is done is known as Non Contacting method.

Non-Contacting are further divided into two types:-

- a) Aperture Coupling
- b) Proximity Coupling

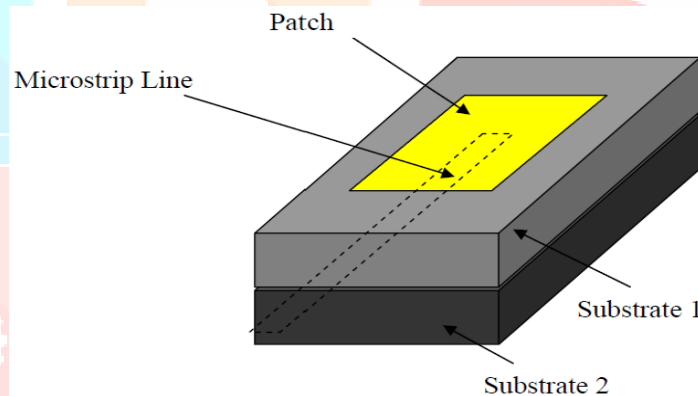
a) Aperture Coupling:-



The radiating patch and the microstrip feed line are separated by the ground plane in this type of feeding technique. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane and variations in the coupling will depend upon the size i.e. length and width of the aperture to optimize the result for wider bandwidths and better return losses. The coupling aperture is usually centered under the patch, leading to lower cross-polarization due to the symmetry of the configuration. Since the ground plane separates the patch and the feed line, spurious radiation is minimized.

Aperture coupled feeding is attractive because of advantages such as no physical contact between the feed and radiator, wider bandwidths, and better isolation between antennas and the feed network. Furthermore, aperture-coupled feeding allows independent optimization of antennas and feed networks by using substrates of different thickness or permittivity.

b) Proximity Coupling:-



Proximity coupled feed is also called as 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. It eliminates fake feed radiation and provides very high bandwidth (as high as 13%) due to an overall increase in the thickness of the 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. This method is beneficial 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 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.

DGS(Defected Ground Structure)

Here we are using U-shape defected ground structure. The analysis of the proposed Rectangular Microstrip Patch Antenna (RMSA) is designed for the resonant frequency of 2.4 Ghz. Then an U slot is introduced and optimized in order to provide multiband and wideband response.

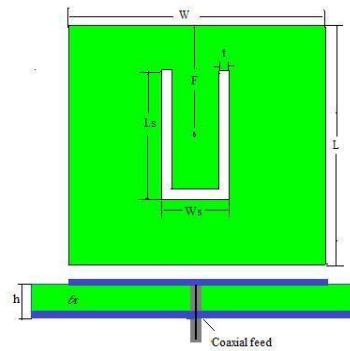


Fig: U slot patch antenna

Flow Chart For Designing

It integrates simulation, visualization and solid modeling. Typical uses of HFSS in package modeling, PCB board modeling, antenna mobile communications, connectors, and waveguides. The common uses of HFSS are antenna analysis, antenna placement, scattering problem and analysis of other RF components.

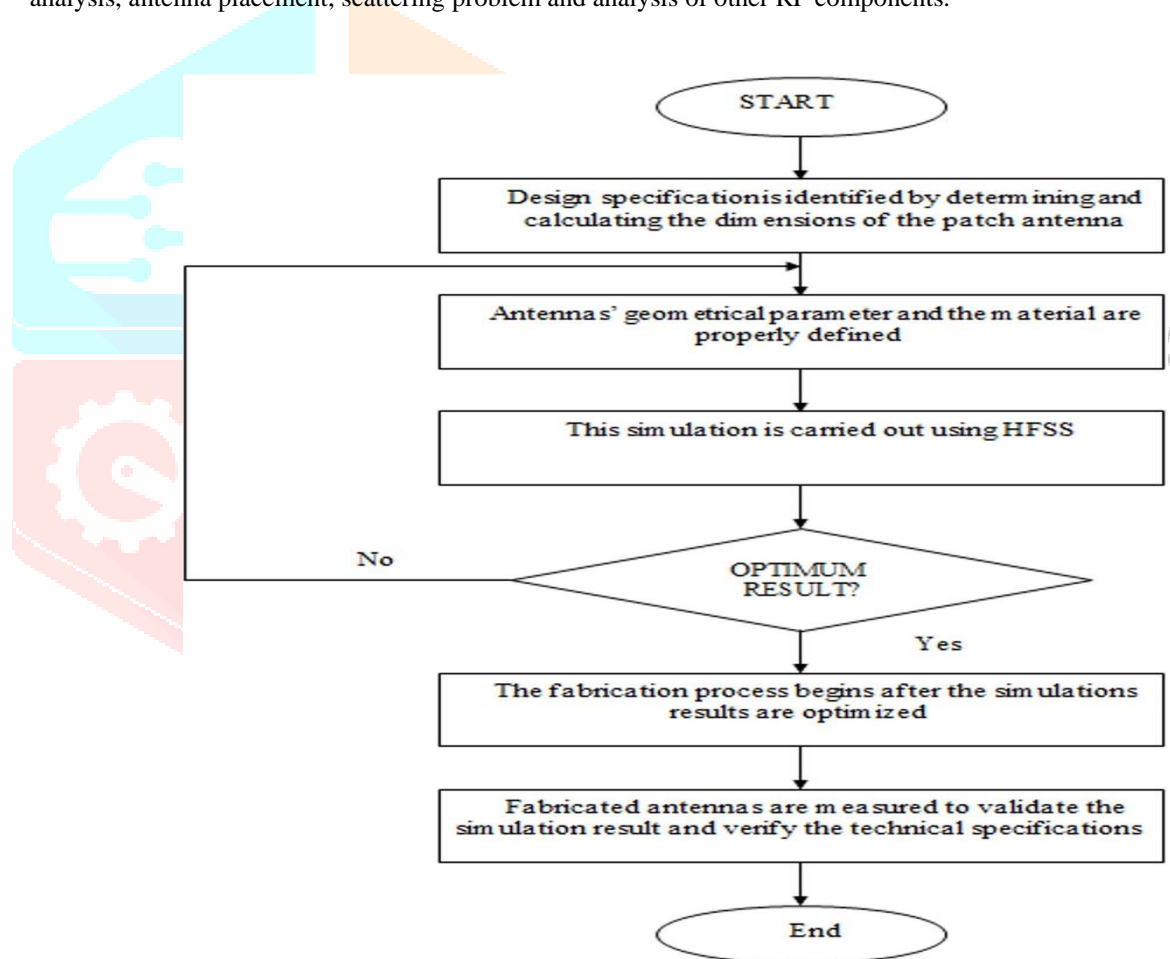


Fig: Flowchart for designing

IV. RESULTS

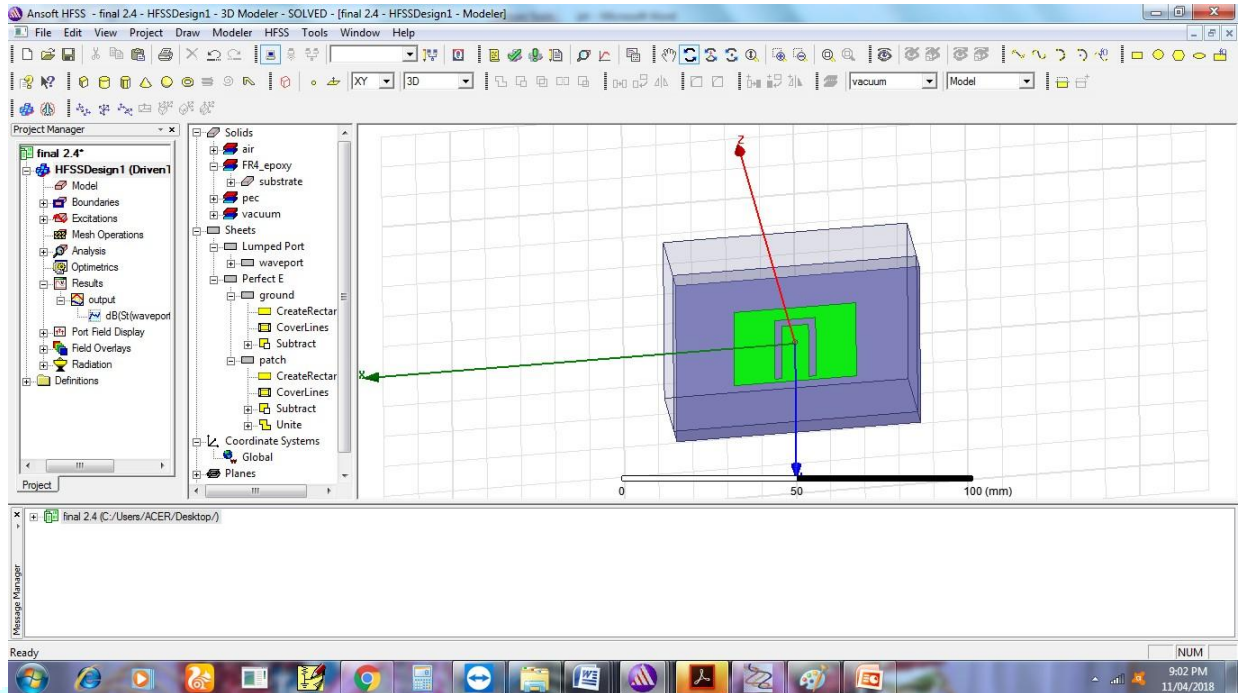


Fig: HFSS microstrip patch antenna designing model

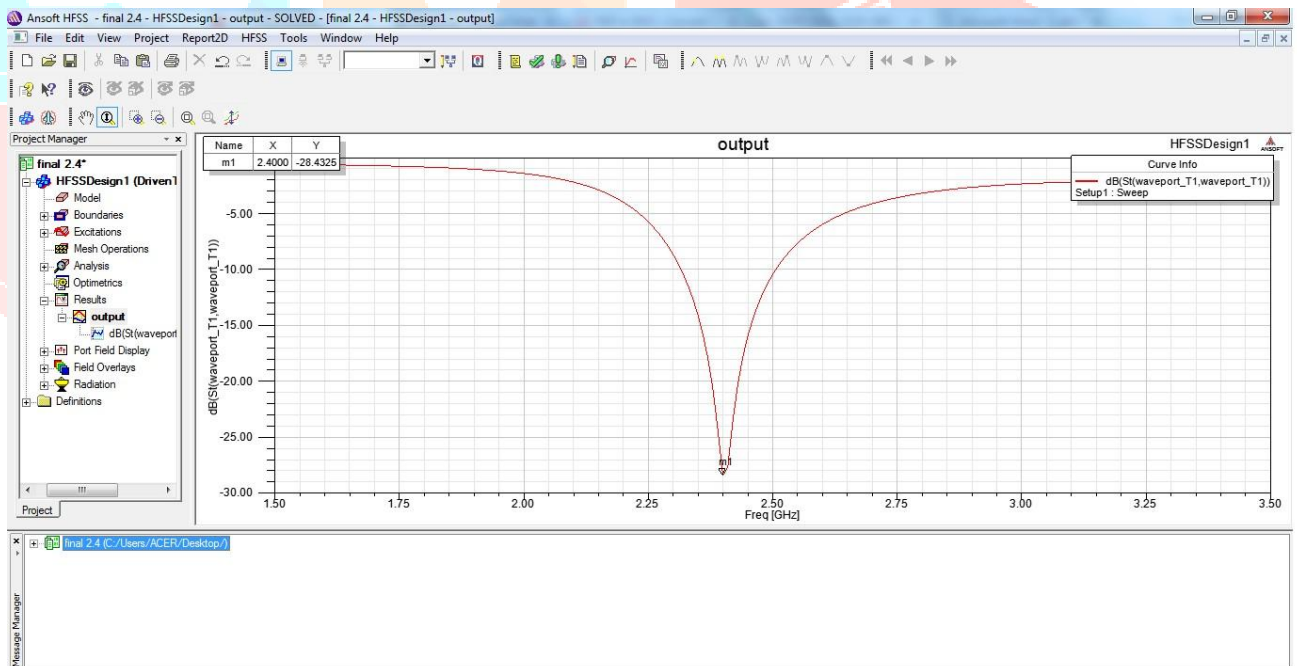


Fig: Simulation output of a Microstrip patch antenna

V. Advantages

- Support linear as well as Circular Polarization.
- Low Fabrication Cost. Hence Mass Production is Possible.
- Low Profile Configuration
- Low Volume and Light Weight
- Can be easily integrated into microwave integrated circuit.
- Mechanically Robust when mounted on Rigid Surface.

VI. FUTURE SCOPE

Due to use of transmission line at higher frequencies to design a network, the world is moving towards compactness. Hence, there is a need to investigate antennas for this domain. Due to the need for small size and compactness, Microstrip antenna which is based on the transmission line and waveguide theory come into the picture.

The Microstrip patch antennas are well known for their performance due to the ease of mounting, robust design, fabrication ease. Due to their extensive usage, the advantages of these Microstrip patch antenna will have to overcome the basic demerits such as low bandwidth and gain. The applications are in various fields such as an in the medical application, satellites and of course even in the military systems just like rockets, aircraft, and missiles. The uses of Microstrip patch antenna also leading to commercial applications such as mobile-based applications to fulfill the requirements of portability and mobility.

VII. CONCLUSION

In this project, we are using Microstrip patch antenna because of its low volume, thin profile configuration, and lightweight. But there are some drawbacks of this antenna-like narrow bandwidth, low gain, and low efficiency. To overcome this drawback we are using different shapes of the defected ground structure. Hence by introducing defected ground structures in different ways, the performance of planar antenna was improved to achieve good impedance matching, compactness of structure. The DGS can be further studied to carry on the work to increase the gain and directivity of the planar antenna.

VIII. REFERENCES

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