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Analysis and Design of an X Band Patch Antenna for Remote Sensing Based on the Satellite Communication

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Abstract - The main objective of this project is to represent the various design implementation using the software ANSYS HFSS. The FR4 epoxy microwave dielectric board (ε_γ = 4.4 *and* tan δ = 0.02) is used to design and construct the prototype. The antenna parameters such as Gain, Radiation Pattern, and Polar Plot, as well as the performance of the designed antenna is also included in this study. The left side antenna frequency range (9.01GHz-10.51GHz) and center frequency range 9.8GHz and right side of the frequency range(9.51GHz-10GHz) and center frequency range 9.7GHz, making it ideal for a variety of applications including satellite communication, medical applications, and other wireless systems. This software designed in the ANSYS and simulation is carried out using high frequency simulation structure (HFSS) program. The entire project revolves around the development of a X band patch antenna for remote sensing satellite application.

***Key Words*: Patch antenna, HFSS design,3D polar plot, s-parameter. radiation pattern**

1.INTRODUCTION

Communication is a way to exchange information between two persons or between two devices or between a person and device. It is a way of transferring information or data. Communication between any two people living in any part of the world is only possible with the help of the emerging technology in day today life. In day to day life electronic devices is manufactured at high speed in order to meet the needs of people to communicate with each other irrespective of their locations.

Every antenna device or every communicating media consists of an antenna which is used to transmit or receive the signals. So antenna is an important source to communicate so that information can be easily transmitted and received. Whether we are talking about wired communication or wireless, land to land or land to space, antenna plays a vital role for transferring information or data. Satellite which transmit information from the large distances consist of the antenna. It is only by the help of antenna we can receive or transmit information from these satellites.

Antenna is transducer to convert the one form energy into another form energy. antenna is a metallic structure that captures and/or transmits radio electromagnetic waves. Other devices in which antenna plays a significant role are wireless communication, Radars, GPS devices, WIMAX, MIMO, laptops, transceivers, space vehicle navigation, airplanes and many other devices.

2.METHODOLOGY

In this chapter, the simulation tool High Frequency Simulation Software (HFSS) which is used for the designing and simulation of the antenna.

HFSS is an interactive software package for calculating the electromagnetic behavior of a structure designed by Ansys. The software includes post-processing commands for analyzing this behavior indetail.

Using HFSS, we can compute

- Basic electromagnetic field quantities and, for open boundary problems, radiated near and far fields.
- Characteristic port impedances and propagation constants.
- Generalized S-parameters and S-parameters renormalized to specific port impedances.
- Radiation pattern and Gain in Rectangular, 2D and Polar plots.
- The Eigen modes, or resonances, of a structure

HFSS is the industry-standard simulation tool for 3D full wave electromagnetic field simulation. HFSS provides E-Fields, H-Fields, currents, S- parameters and near and far field radiation field of the results.

The procedure which is followed in the designing of the structures in HFSS design. Drawing the aerial design model of the structure that will be analyzed is the first step in the creating of the HFSS model. Then the objects that are being drawn are assigned thematerials of which they are made and various other properties like transparency, color etc.

The next step is to define the boundaries for the structure such as perfect electric or magnetic conductor. After defining the boundaries, the structure is excited by the port the voltage source which needs to be excited. Once the boundaries

and excitations are defined the structure is completely modeled and the solution is set up for the structure. This solution step requires the assignment of the frequency sweep at which adaptive mess requirement takes place After completion of the solution step the structure is simulated and after the simulation the solution data is post-processed which includes the graphs for the various parameters such as S11 parameter,

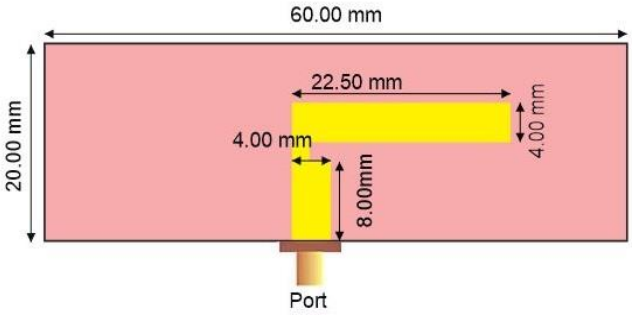

Fig 1: right side patch antenna

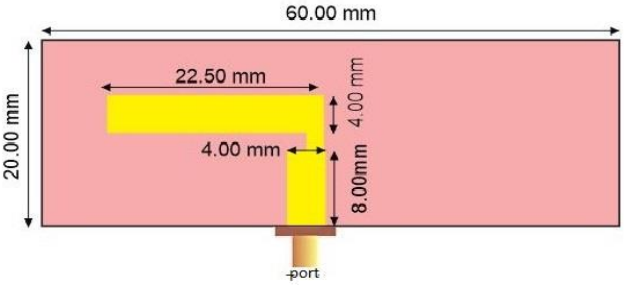

Fig 2: left side patch antenna

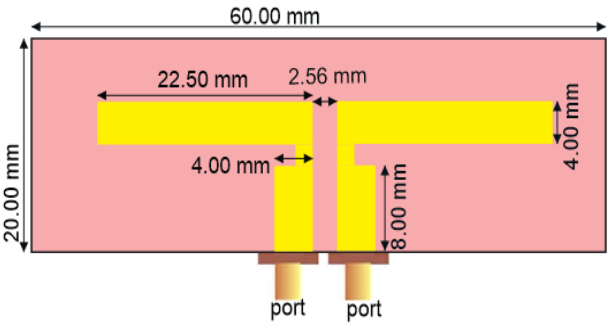

Fig 3: full size of patch antenna

TABLE 1: Dimension of the proposed antenna

ANTENNA PARAMETERS	GROUND	SUBSTRATE	PATCH
Length(mm)	60.00	60.00	22.50
Width(mm)	20.00	20.00	4.00

3.RESULT AND DISCUSSION

3.1The left and right side Reflection coefficient of patch antenna

The left side patch antenna analysis has been carried out by using HFSS simulator software and the antenna was resonating at a frequency 9.8GHz, reflection coefficient is the -25. 9732dB.The X band patch antenna for remote sensing lines and sight for the satellite communication. This is when the substrate FR4 material is used.

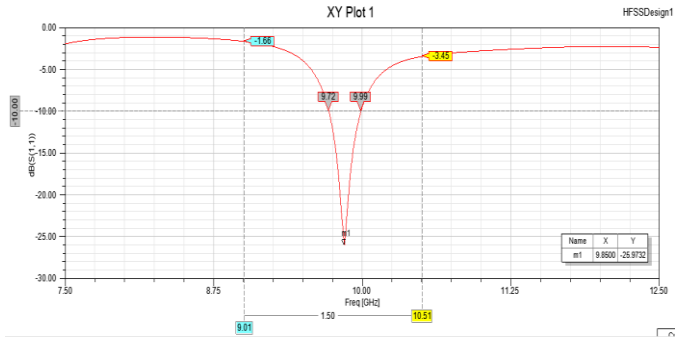

Fig 4: reflecttion coeffient of left side patch antenna

The right side patch antenna analysis has been carried out by using HFSS simulator software and the antenna was resonating at a frequency 9.7GHz, reflection coefficient is the -23. 5732dB.The X band patch antenna for remote sensing lines and sight for the satellite communication. This is when the substrate FR4 material is used.

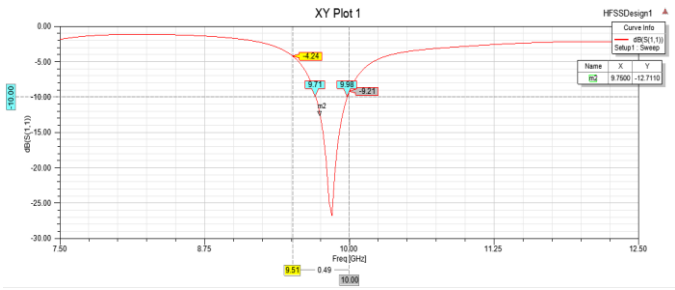

Fig 5:reflection coefficent of right side patch antenna

3.2 3D-Gain plots of left and right side patch antenna

The 3D radiation plot helps in depicting- the gain of the antenna as well as the directivity of the antenna. As per the above the radiation occurs at the angle between z axis and x axis. Here, the left side gain of the patch antenna is 3.0474dB and right side gain of the patch antenna is which is quite satisfied for radiating. The actual gain that has to be attained from a patch antenna is 4.9697dB. The 3D plot plots for the both of the patch antenna at every possible phi values and theta values. These are the values used to determine an antenna's gain at a particular distance.

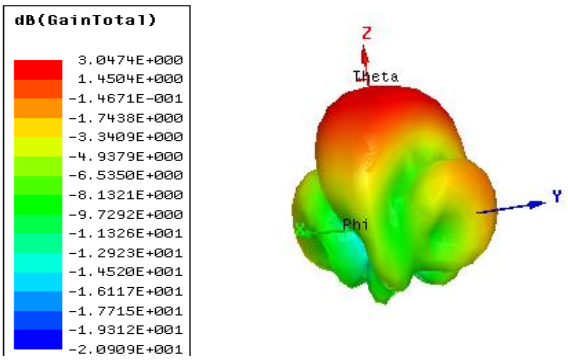

Fig-6 left side of the 3D polar plot

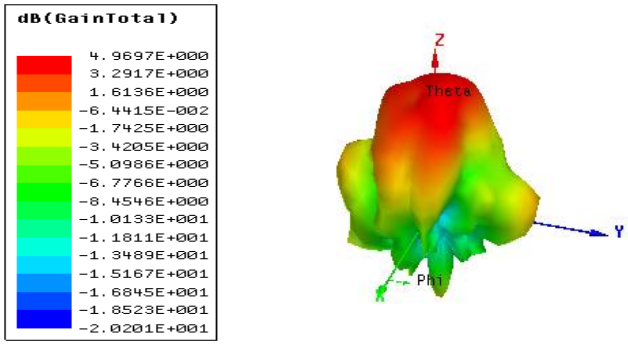

Fig -7 right side of the 3D polar plot

3.3 Surface current distribution for left and right side of the patch antenna

Current distribution for left side of the patch antenna at frequency 9.8GHz. The figure shows the current density and flow of e- field movement inside the proposed antenna along with density meter.

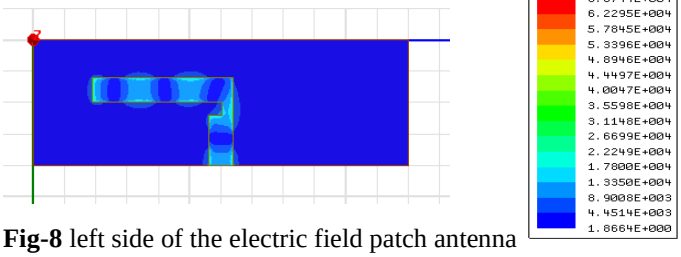

Fig-8 left side of the electric field patch antenna

Current distribution for right side of the patch antenna at frequency 9.7GHz. The figure shows the current density and flow of e- field movement inside the proposed antenna along with density meter.

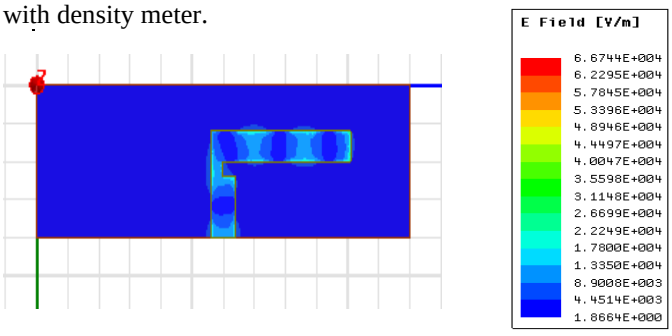

Fig-9 right side of the electric field patch antenna

3.4 Radiation pattern for left and right side of the patch antenna

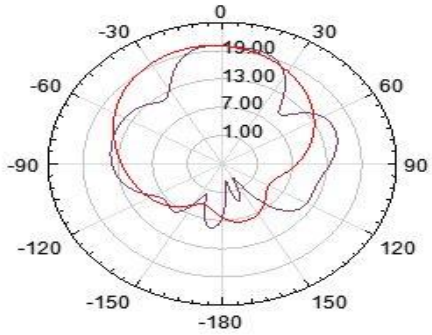

Fig 10-left side of the radiation pattern

Above, Fig. 10 represents the left side of the patch antenna direction of radiation plots. Directional pattern contains radiation properties with respect to spatial coordinates. It includes the intensity of radiation, strength of electric field or magnetic field, directivity of antenna, polarization properties of antenna.

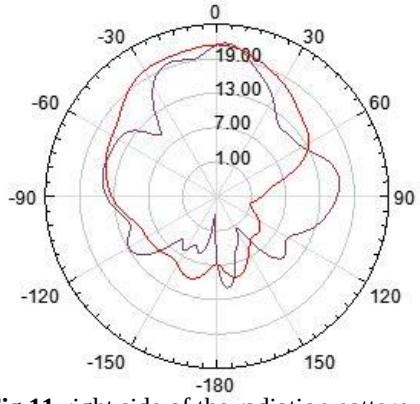

Fig 11-right side of the radiation pattern

Above, Fig. 11 represents the right side of the patch antenna direction of radiation plots. Directional pattern contains radiation properties with respect to spatial coordinates. It includes the intensity of radiation, strength of electric field or magnetic field, directivity of antenna, polarization properties of antenna.

4. CONCLUSION

The design provides the best outcomes and gains, a decent radiation pattern, and aids in understanding the many methods to achieve the desired outcomes. The design miniature the size of antenna and results in better return loss, bandwidth. This antenna is well suited for satellite communication. Patch antenna produces two resonating frequencies with adequate bandwidth and better return loss by further incorporating techniques like bandwidth improvement and better reflection coefficient. This work helps to know about how the software HFSS is used in implementation of the design and analysis the results.

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