

Design of a Rectangular Microstrip Patch Antenna with Edge Feeding Technique for Marine Applications

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Abstract

This proposed method serves purpose of designing a rectangular patch antenna of Micro-strip with 5.2 GHZ as frequency of resonance for marine applications. Design is performed in ANSYS High Frequency Structure Simulator (HFSS). Patch antenna of rectangular is created with FR4epoxy substrate. Reflection coefficient for this design is obtained in 5.2GHz frequency range. The excitation given to this patch antenna is Edge Feed with a fixed length and width. The performance parameters such as S-parameter, Gain, VSWR, directivity of the antenna is obtained and analyzed for the marine applications.

Keywords: ANSYS HFSS, Edge Feed, FR4 epoxy, S-parameter, Gain, Directivity, VSWR.

1. INTRODUCTION

Antennas are unit key parts of any wireless communication system. They have the characteristics of converting any type of signal into waves that can be transmitter wirelessly for longer distance. The signal that is transmitted is received by a receiving antenna. The data or the information is transmitted as electromagnetic waves. The receiver antenna has a property of reciprocal process which converts this

electromagnetic waves into a signal or voltage that is given as input to the other end of a system under communication. The main function of antenna is radiation characteristics. Transmission line defines this. Transmission line which conducts current with uniform velocity, and a straight line with infinite extent does not radiate power.

Antenna of Micro-strip patch is the foremost type of printed antenna. It has a major role in wireless communication systems. Fabrication can be easily done using micro strip antenna. Ground plane, substrate and radiating patch are there in a structure of this antenna. Patch dimensions defines radiating feature of antenna. Length and width parameters are used for representing patch. Material used to make substrate is FR4 epoxy. These materials are durable for a long range of frequency. The frequency ranges used to excite and analyze antenna is 5.2GHz.

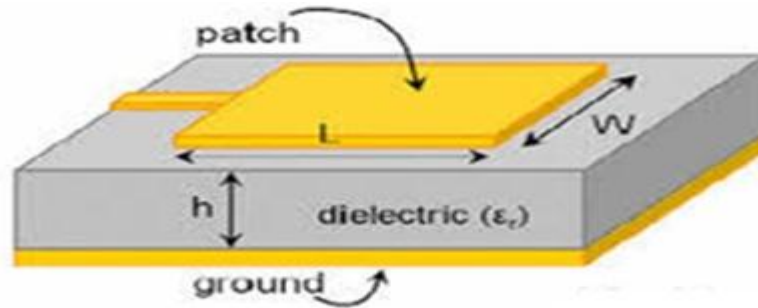


Figure 1.1 Microstrip patch antenna

Antenna design is done in ANSYS High Frequency Structure Simulator (HFSS) tool. It is a 3D simulation tool applicable for high frequency electronic elements as antenna and antenna arrays. This software tool has worldwide application that can be used in wireless communication, radar applications, satellite communication, Internet of things products. It solves the problems in 3D EM design. Complete analysis and provides guaranteed accuracy as result. The parameters necessary to analyse the antenna can be viewed in 2D and 3D model for accurate analysis.

2. BLOCK DIAGRAM

The designed antenna can be used to transmit the information from signal processing unit to satellite. The properties of Ocean in underwater are dissolved gases, Salinity, temperature, density, colour can be studied using this microstrip patch antenna at 5.2 Ghz frequency.

Dissolved gases: In seawater, Carbon dioxide, argon, oxygen and nitrogen are the major dissolved gases. In ocean, dissolved gases distribution is controlled by following general factors. A) salinity and temperature, B) biological activity, C) currents and mixing process. At surface, water concentration and with atmosphere in equilibrium, is computed by salinity and temperature. Carbon dioxide and oxygen

concentration is affected by biological activity. Through eddy diffusion and mass movement, biological activity effect is modified by the process of mixing and current.

Colour: Pure water is impeccably clear, yet in the event that there is a ton of water, and the water is profound so that there are no reflections off the ocean bottom, the water shows up as a dim naval force blue. The explanation the sea is blue is because of the assimilation and dissipating of light. The blue wavelengths of light are dissipated, like the dispersing of blue light in the sky yet ingestion is an a lot bigger factor than dispersing for the reasonable sea water. In water, assimilation is solid in the red and powerless in the blue, subsequently red light is retained rapidly in the sea leaving blue.

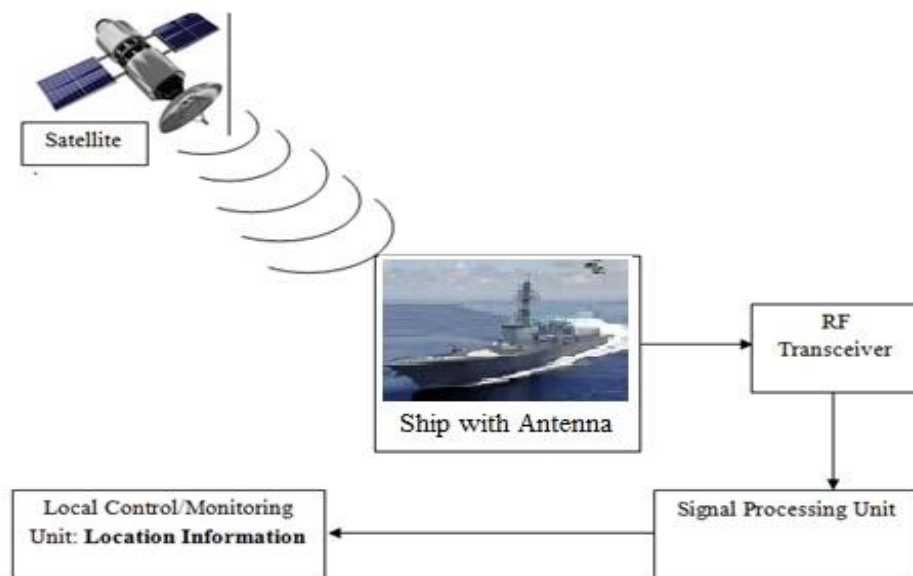


Figure 1.2 Block Diagram

3.FEEDING TECHNIQUES

Feeding is the basic process for establishing connection between transmitter and receiver antenna and make them connected for transfer of information. As the antenna operates in radio frequency the feeding is created in same range. The communication between the antenna happens through radio frequency signal.

2.1 Edge Feed Technique:

This feeding is provided through a feedline that connects the external edge feed on the substrate with the radiating patch. The design is made such a way that width of feed element is less than radiating patch.

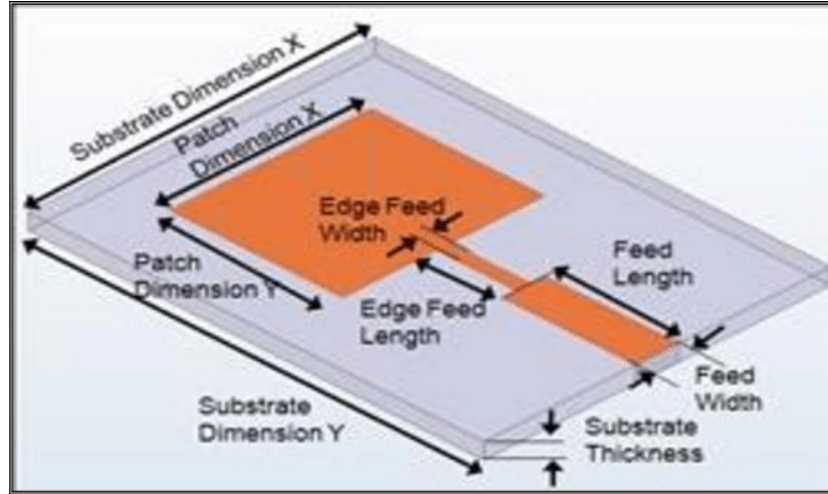


Figure 1.3: edge feed

4. MICROSTRIP PATCH ANTENNA OF RECTANGULAR DESIGN

A Rectangular Microstrip Patch Antenna is designed to operate at 5.2 GHz frequency with edge feeding technique. The proposed design is created with the substrate with FR4 epoxy under dielectric constant $\epsilon_r = 4.4$. The length of radiating patch is 12.56 mm and width is 17.56mm for edge feed.

The dimensions for designing antenna is calculated as below

For calculating width of the patch ,the following equation is used,

$$W = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}} \times \sqrt{\frac{2}{\epsilon_r + 1}}$$

The length can be evaluated as,

$$L = \frac{1}{2f_r\sqrt{\epsilon_{eff}}\sqrt{\mu_0\epsilon_0}} - 2\Delta L$$

Where ,

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2\sqrt{1 + 12\frac{h}{w}}}$$

$$\Delta L = \frac{(\epsilon_{r_{eff}} + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\epsilon_{r_{eff}} - 0.258)\left(\frac{w}{h} + 0.8\right)} * 0.412h$$

5. DIMENSIONS OF PROPOSED DESIGN

Table 1.1: Edge feed technique

PARAMETERS	EDGE FEED
Resonant Frequency(fr)	5.2GHz
Substrate	FR4 epoxy
Dielectric constant	4.4
HeightofSubstrate	1.6mm
Width of Patch	17.56mm
LengthofPatch	12.56mm
Substrate Length	58.94mm
Substrate Width	35.9mm
Ground Plane Length	58.94mm
Ground Plane Width	35.9mm

6. SIMULATION OUTCOMES

6.1. EDGE FEED:

a) Return Loss:

Power loss is represented by return loss. It is caused because of channel or transmission line discontinuities. Signals are returned due to this in transmission process.

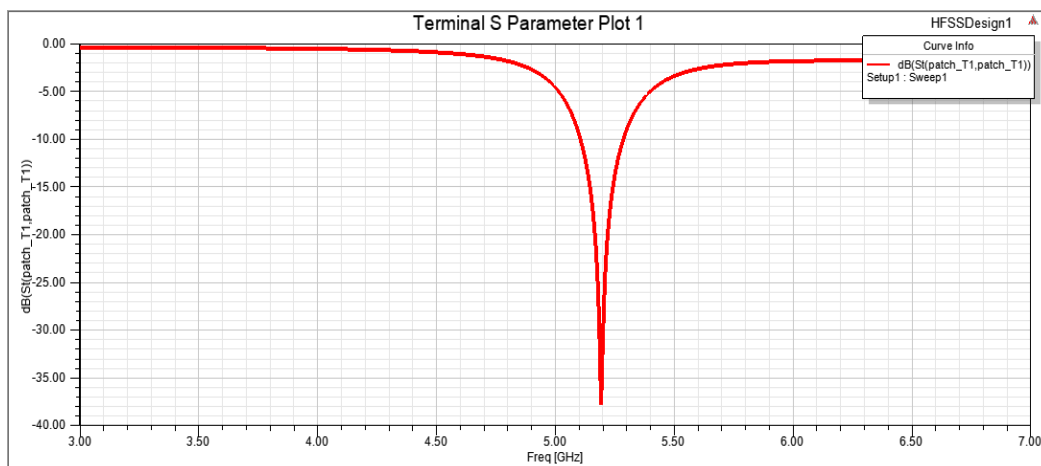


Figure 1.4 Return loss for edge feed

From the above result, it is shows return loss is very narrow at the radiated 5.2Ghz frequency . This indicates that the antenna exhibits perfect radiation.

b) VSWR:

VSWR is known as Voltage Standing Wave Ratio. This is analyzed to know about the impedance matching of antenna.

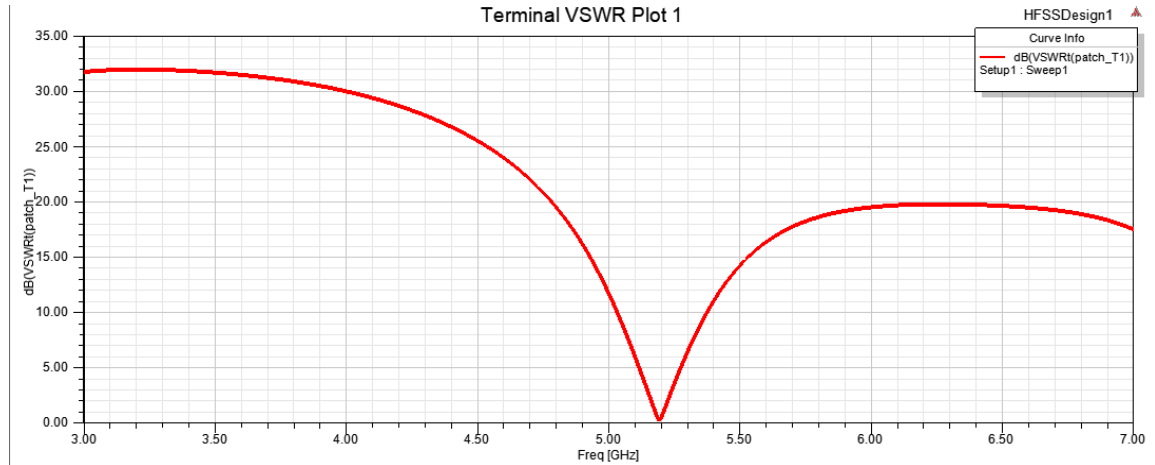


Figure 1.5 VSWR

From the above result it is analyze that in 5GHz - 5.5GHz range of frequency, there will be a constant value of VSWR.

c) GAIN:

This describes how much amount of power is radiated from the antenna. The maximum radiation is obtained based in the frequency applied. If the value obtained is not optimized then the performance of antenna is low.

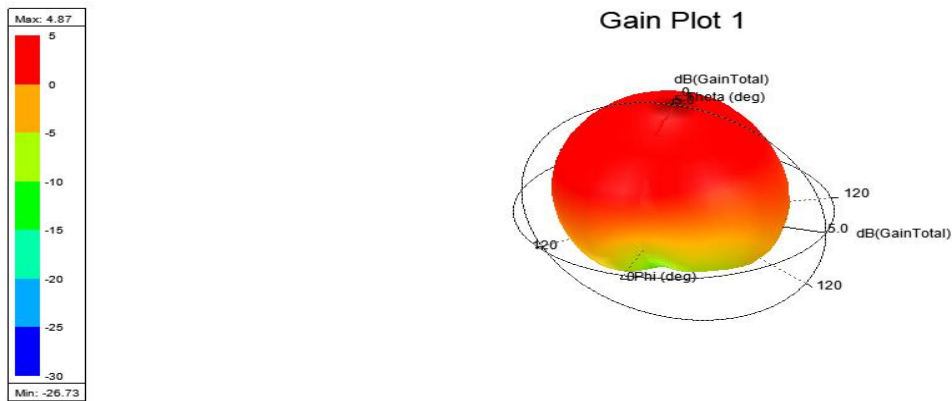


Figure 1.6 Gain

7. CONCLUSION

ANSYS HFSS (High Frequency Structure Simulator) is used for designing patch antenna of micro-strip. Concept can also be developed using that. The edge feeding technique is applied to the antenna that is designed. From the calculated results it is clear that the antenna works accordingly for the marine environment applications.

As the outlook work can be extended to convert the designed antenna into reconfigurable antenna and analyze the performance.

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