

Design & Simulation of single frequency Rectangular Patch Antenna by Using HFSS

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ABSTRACT

An enhanced but simple single band Rectangular patch antenna is presented. This compact micro strip antenna is obtained by inserting small coaxial feed in a Rectangular patch antenna. The antenna has been designed and simulated on an RTduroid substrate with dielectric constant of 2.2 and thickness of 3.2mm. The design is analysed by finite element method based HFSS simulator software (version 13.0). The simulated return loss obtained is -31.4402db at 2.4GHZ respectively. Therefore this antenna is applicable for SHF band applications.

Keywords– Frequency, Gain, HFSS, Patch Antenna, Return Loss, Substrate, SHF

I. INTRODUCTION

In recent years there is a need for more compact antennas due to rapid decrease in size of personal communication devices. As communication devices become smaller due to greater integration of electronics, the antenna becomes a significantly larger part of the overall package volume. This results in a demand for similar reductions in antenna size. In addition to this, low profile antenna designs are also important for fixed wireless application. The microstrip antennas used in a wide range of applications from communication systems to satellite and biomedical applications.

In order to simplify analysis and performance prediction, the patch is generally square, rectangular, circular, triangular, elliptical or some other common shape. The rectangular microstrip patch antenna is the widely used of all the types of microstrip antennas that are present. The substrate material, dimension of antenna, feeding technique will determines the performance of microstrip antenna. Among different feeding techniques, coaxial fed technique is used for the design of rectangular microstrip patch antenna at 2.4GHz. The substrate material mainly used for design technique is Rogers RT duroid 5880(tm) with $\epsilon_r=2.2$. The software tool HFSS is used because it is a high performance full wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modeling. It integrates simulation, visualization, solid modelling, and automation in an easy to learn environment where solutions to your 3D EM problems are quickly and accurate obtained.

II. FEEDING TECHNIQUES

Different methods are available to feed microstrip patch antennas. These methods can be contacting and non-contacting methods. There are

many feed techniques but the four most popular feeding techniques used are microstrip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes).

2.1 Microstrip Line Feed:

In this, a conducting strip is connected directly to the edge of the microstrip patch. The conducting strip is smaller in width as compared to the patch. This kind of feed arrangement has the advantage that the feed can be etched on the same substrate structure.

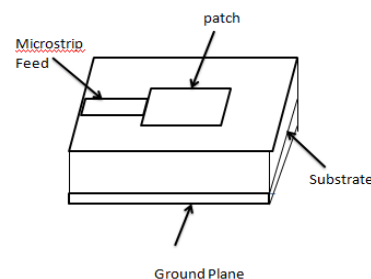


FIG 1:Microstrip line feeding

2.2 Coaxial Feed:

In this, the inner conductor of the coaxial connector extends throughout the dielectric and is soldered to the radiating patch, while the outer conductor is coupled to the ground plane.

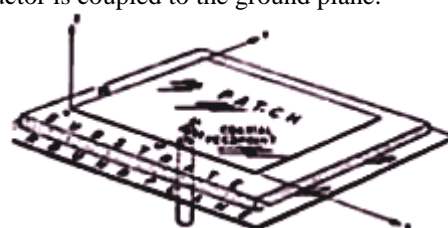


FIG 2:Microstrip coaxial feeding

2.3 Aperture Coupled Feed:

In this technique, the radiating patch and the microstrip feed line are separated by the ground plane. The patch and the feed line is coupled through a slot in the ground plane. The main disadvantage of this feed technique is that it is difficult to fabricate due to multiple layers, which also increases the antenna thickness.

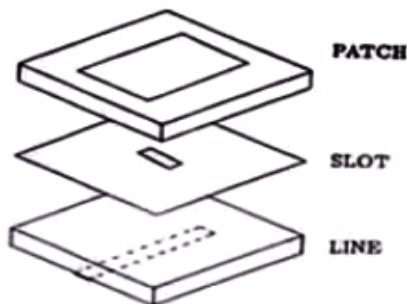


FIG 3:Aperture coupled feeding

2.4 Proximity Coupled Feed:

This type of feed technique is also called as the electromagnetic coupling scheme. Two dielectric substrates are used and the feed line is between the two substrates. The radiating patch is on top of the upper substrate. The main advantage of this feed technique is that it eliminates spurious feed radiation and provides high bandwidth.

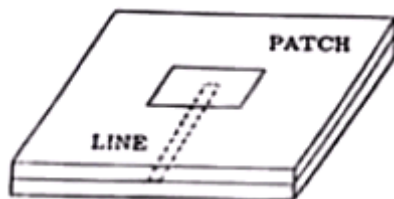


FIG 4:Proximity coupled feeding

III. RECTANGULAR PATCH ANTENNA DESIGN

The designing Equations are

$$W = \frac{v_0}{2f_r} \sqrt{\frac{2}{\epsilon_r + 1}} \quad (1)$$

$$L = \frac{v_0}{2f_r \sqrt{\epsilon_{\text{reff}}}} - 2\Delta L \quad (2)$$

$$\epsilon_{\text{reff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[1 + 12 \frac{h}{W} \right]^{-1.2} \quad (3)$$

$$\Delta L = 0.412h \frac{(\epsilon_{\text{reff}} + 0.3)(Wh + 0.264)}{(\epsilon_{\text{reff}} - 0.258)(Wh + 0.8)} \quad (4)$$

By using above equations the parameters of antenna are obtained and the feeding position of antenna has been varied to get the required gain and bandwidth. The above parameters are analyzed in HFSS simulator, Perfect Electric Conductor is used as material for patch which is three dimensional object and it is operating at 2.4 GHz.

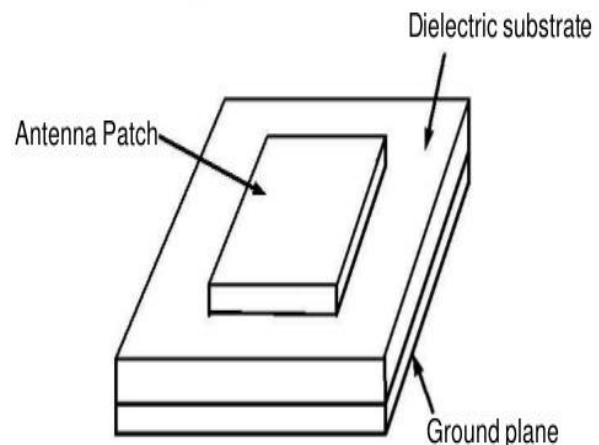


FIG 5: Rectangular Patch Antenna

IV. PROPOSED RECTANGULAR PATCH ANTENNA DESIGN USING HFSS

The proposed antenna is shown in fig.2. Initially a rectangular patch antenna is considered with of length and width 30 and 40 respectively. Adjust the electromagnetic coupling effect a coaxial feed is placed in Rectangular antenna.

Finally the proposed antenna consists of a single slot in the radiation patch that plays an important role in determining the resonating frequency of this antenna because they can adjust the electromagnetic coupling effects between the patch and the ground plane and improve its impedance bandwidth.

The proposed antenna with a coaxial feed placed on a dielectric substrate with a thickness of 3.2 mm and permittivity of 4.4. The gain and impedance matching of the antenna can be modified by varying radius.

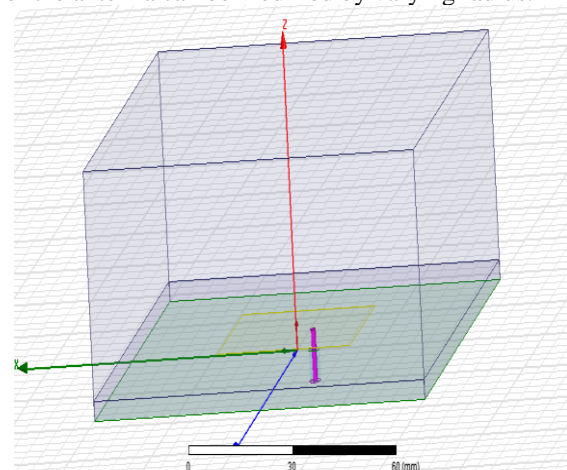


Fig 6: Proposed Rectangular Patch Antenna

V. HFSS SIMULATION RESULTS

This antenna is designed and optimized with the aid of Ansoft HFSS ver.13.0.

The S-parameter (return loss), VSWR and 3D Polar Plot of the proposed antenna is Discussed here.

5.1 Return Loss

The Rectangular Patch antenna has return loss of -31.4402 db at 2.4 GHz.

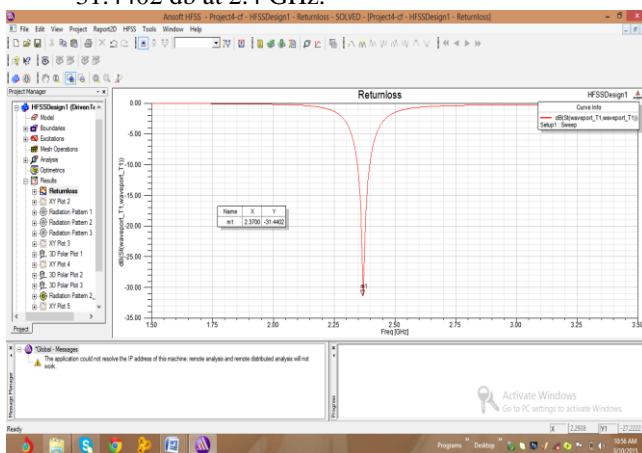


FIG 7: Return Loss

5.2 VSWR

The parameter VSWR is a measure that numerically describes how well the antenna is impedance matched to the radio or transmission line it is connected to. VSWR must be less than 2. For this antenna the VSWR reading is 0.4655.

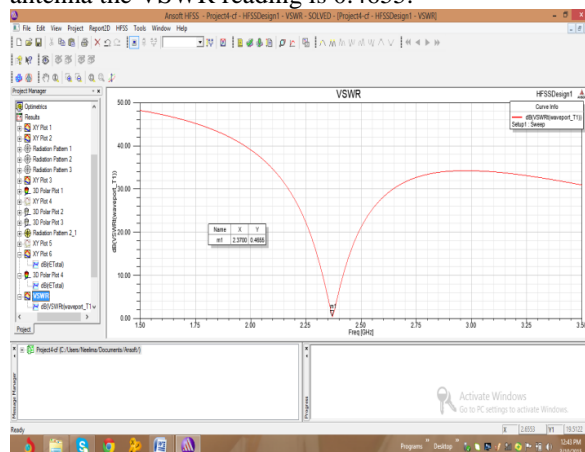


FIG 8: VSWR

5.3 3D Polar Plot

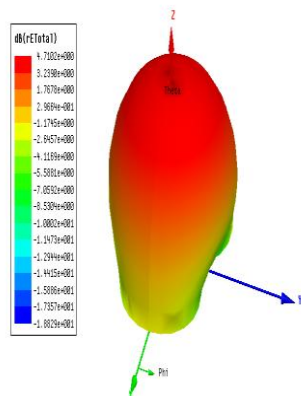


FIG 9: 3D Polar plot

From polar plot it is clear that the radiations is along Z direction.

VI. CONCLUSION

A single band Rectangular patch antenna is presented in this letter. This antenna has a simple structure which is easy to be integrated in miniature devices. Results show that the frequency bandwidth covers 0.0513GHz with return loss of -31.4402db where measured and simulate results are in good agreement. Measured results show good impedance matching. From above it is clear that the antenna will work good in SHF band for satellite and Mobile applications.

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