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Modeling and design of single rectangular patch antenna with edge feed

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ABSTRACT

A microstrip antenna consists of a dielectric substrate sandwiched between two conducting surfaces, the antenna plane, and the ground plane. The simplified design of the rectangular microstrip patch antenna with edge feed. For this study, the dielectric constant of the dielectric substrate chosen is of height and the loss tangent tanδ= 0.0019. The patch dimensions are dependent on the desired frequency for which the antenna has to be designed. The patch dimensions for the desired frequency are obtained by the transmission model analysis, after the construction of the model of the patch antenna the boundary conditions and the excitations has to be assigned. The patch and the ground plane are perfect electric conductors, so they are assigned as the Perfect E conductors. And the box between the patch and the ground plane is assigned the material with the specified dielectric constant.

***Keywords**: Microstrip, Rectangular patch*

1. INTRODUCTION

For planar structures, the method of moments or that of the finite element is quite popular. In order to streamline the antenna design process and generate accurate results before prototype construction, it is important to select an EM simulation program. The HFSS software is a full wave EM analysis tool. Microstrip antenna models that account for the dielectric substrate in a rigorous manner are referred to as full wave solutions. Features of the full wave solutions include the following:

Accuracy: full wave analysis techniques generally provide the most accurate results for input impedance, mutual coupling, Radar Cross Section (RCS).
Completeness: full wave solutions include the effects of surface waves, space wave radiation, and external coupling.
Versatility: full wave solutions can be implemented for arbitrary microstrip elements and arrays, various types of feeding techniques, multilayer geometries, and for anisotropic substrates.
Computational complexity: full wave solutions are numerically intensive, and require careful programming in order to be computationally efficient [3, 9].

1.1 Perfect E

The Perfect Electric Conductor or PEC Boundary is the HFSS default boundary that is applied to all outer faces of the solution space. It represents a lossless perfect conductor. This default boundary creates a closed model. This boundary can also be used to create a symmetry plane if it is placed on an outer face of the solution space.

1.2 Design guidelines for patch antenna:

The following guidelines are must for designing patch antenna fed by Microstrip lines:
1. The length of the patches may be changed to shift the resonances of the center fundamental frequency of the individual patch elements. This is true in general, even for more complicated microstrip antennas that weave around the length of the longest path on the microstrip controls the lowest frequency of operation.

$$f_c \propto \frac{c}{2l\sqrt{\varepsilon_r}}$$

2. The resonant input resistance and radiation pattern of a single patch can be decreased by increasing the width of the patch. The wider the patch becomes the lower the input impedance. This is acceptable as long as the ratio of the patch width to patch length (W/L) does not exceed 2 since the aperture efficiency of a single patch begins to drop as (W/L), increases beyond 2.

3. The permittivity ε_r of the substrate controls the fringing fields. Lower permittivity's have wider fringes and therefore better radiation. Decreasing the permittivity also increases the antenna bandwidth. The efficiency is also increased with a lower value for the permittivity. The impedance of the antenna increases with higher permittivity.

4. The height of the substrate H also controls the bandwidth increases the height increases the bandwidth. The fact that increasing the height of a patch antenna increases its bandwidth can be understood by recalling the general rule that "an antenna occupying more space in a spherical volume will have a wider bandwidth". Increasing the height also increases the efficiency of the antenna. Increasing the height does induce surface waves that travel within the substrate [3]

2. RESULTS and DISCUSSION

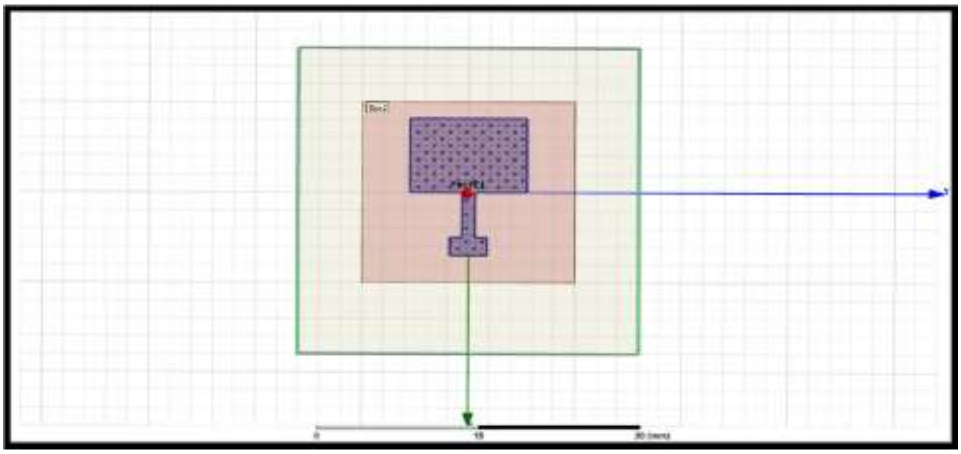

Fig. 1: Model of Rectangular Microstrip patch antenna in HFSS software

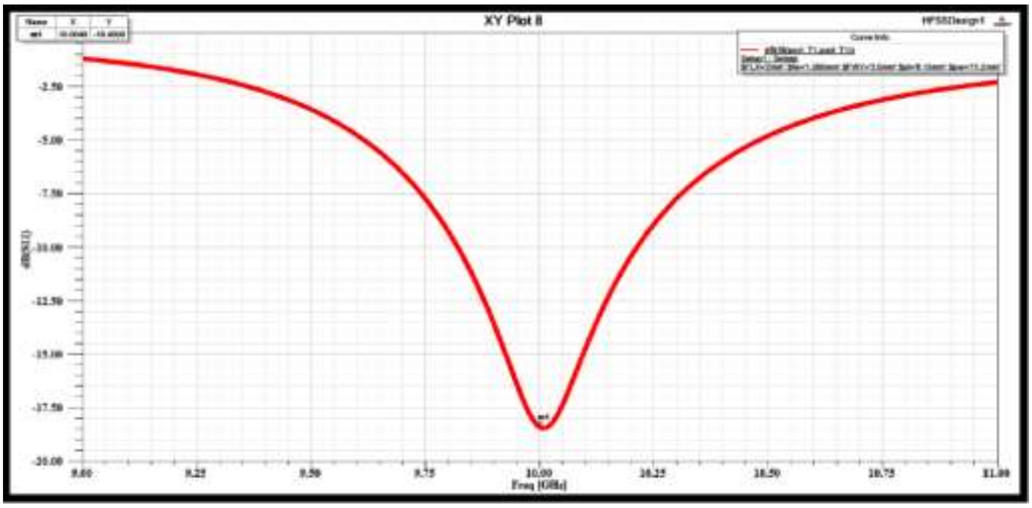

Fig. 2: Plot of Return loss

Here the graph is plotted for S-parameter (S11) vs. Frequency and return loss obtained at the resonant frequency or the desired frequency of 18.45dB.

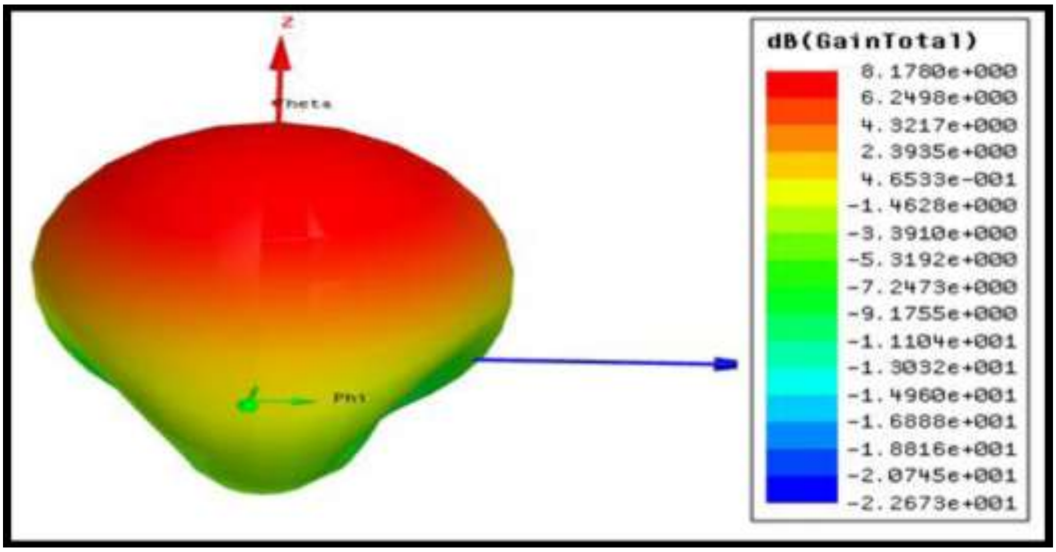

Fig. 3: 3D polar plot of Gain

The above 3D polar plot shows the optimized gain obtained from the modeled rectangular edge fed antenna. The simulated *gain* of the antenna is *8.14dB* which is the highest possible gain for a single patch antenna.

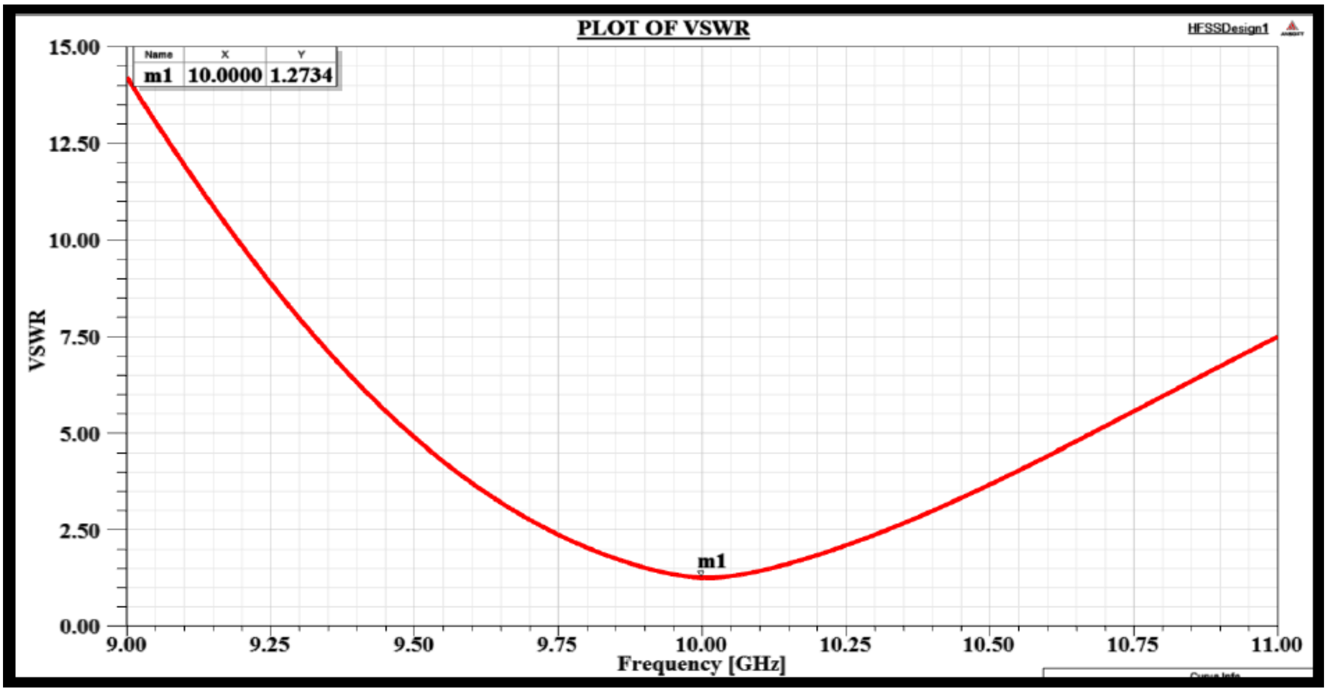

Fig. 4: Plot of VSWR

The figure shows the plot of the *VSWR vs. Frequency*. The graph shows the value of the *VSWR* as *1.2734*

3. CONCLUSION

The rectangular microstrip patch antenna with edge feed is simplified. For this study, the dielectric constant of the dielectric substrate chosen is of height and the loss tangent tanδ= 0.0019. Return loss obtained at the resonant frequency or the desired frequency of 18.45dB and VSWR as 1.2734.

4. REFERENCES

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