Design and Analysis of an Antenna for S-Band Operations

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ABSTRACT

Antenna plays a major role in wireless communications. The type of antenna includes parabolic reflectors, patch antennas, slot antennas, folded dipole antennas etc. Among those, most useful antennas at microwave frequencies (f>1GHz) are micro strip antennas also called patch antennas with a metal patch on top of grounded dielectric substrate. The patch may be in variety of shapes but rectangular and circular are most common.

In this paper the design of rectangular micro strip patch antenna to operate at frequency of 2 to 2.5 GHz with the thickness of 1.6mm and Flame Retardant-4 (FR-4) substrate with a dielectric constant which is approximately 4.4 is proposed. The feeding technique that offers an excess bandwidth of about hundreds of Mega Hertz is also proposed.

The simulation by using Ansoft HFSS verifies the parameters of the antenna. The antenna performance characteristics such as input impedance, VSWR, Return loss and current density are verified.

Keywords*: Microstrip antenna, coaxial feeding, s-band*

1. INTRODUCTION

Antennas play a very important role in the field of wireless communications. Some of them are parabolic reflectors, patch antennas, slot antennas, and folded dipole antennas with each type having their own properties and usage. It is perfect to classify antennas as the backbone and the driving force behind the recent advances in wireless communication technology.

Microstrip antenna technology began its rapid development in the late 1970s. By the early 1980s basic microstrip antenna elements and arrays were fairly well establish in term of design and modelling. In the last decades printed antennas have been largely studied due to their advantages over other radiating systems, which include: light weightiness,reduced size, low cost, conformability and the ease of integration with active device. A microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in figure 1. The patch is generally made of conducting material such as copper or gold. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. Microstrip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. Therefore, and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line or probe feed. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch this includes proximity feeding and aperture feeding.

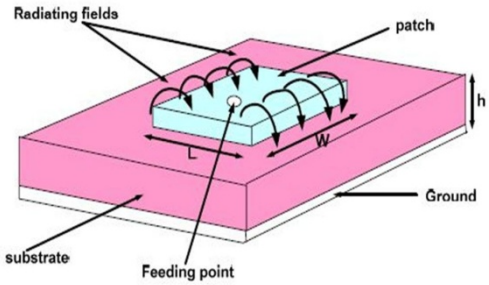

Figure 1: Microstrip patch Antenna

Microstrip antennas are characterized by a larger number of physical parameters than conventional microwave antennas. they can be designed to have many geometrical shapes and dimensions but rectangular and circular microstrip resonant patches have been used extensively in many applications. In this paper, the design of

probe feed rectangular microstrip antenna is for satellite applications is presented and is expected to operate within 2ghz - 2.25ghz frequency span. This antenna is designed on a double sided fiber reinforced (fr-4) epoxy and its performance characteristics which include return loss, VSWR, and input impedance are obtained from the simulation.

2. ANTENNA GEOMETRY

The structure of the proposed antenna is shown in Figure 2.

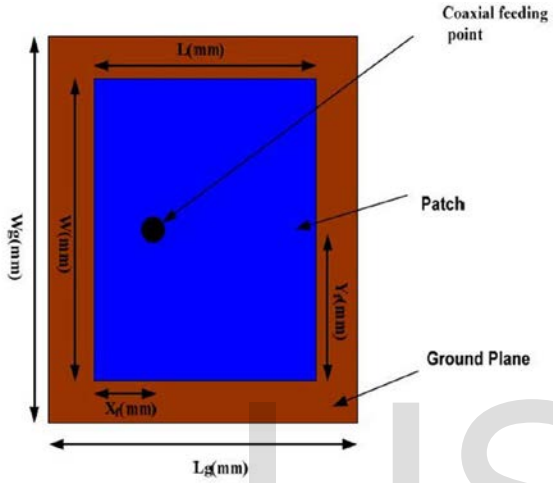

Figure 2: Dimensions of RectangularMicrostrip patch Antenna

For a rectangular patch, the length L of thepatch is usually 0.3333λ< L< 0.5λ, where λ is the free-space wavelength. The patch is selected to be very thin such that t <<λ,where t is the patch thickness. The height h of the dielectric is usually 0.003λ<= h<= 0.05λ. Thus, a rectangular patch of dimension 40.1mm×31mm is designed on one side of an FR4 substrate of thickness 1.6mm and relative permittivity 4.4 and the ground plane is located on the other side of the substrate with dimension 50.32mm x 41.19mm. The antenna plate is fed by standard coaxial of 50λ at feeding location of 11.662mm by 20.286mm on the patch. This type of feeding scheme can be placed at any desired location inside the patch in order to match with the desire input impedance and has low spurious radiation.

3. PHYSICAL PARAMETERS OF ANTENNA

Antenna parameters can be calculated by the transmission line method.

3.1. Width of the patch

The width of the antenna can be calculated by the formula:

$$W = \frac{C}{2f_o\sqrt{\frac{\epsilon_r+1}{2}}}$$

3.2. Length of the patch

Length of the patch is given by

$$L = \frac{\lambda_0}{2} - 2\delta L$$

Where δL is the dimensions of the patch along its length that has been extended on each end.

3.3. Feed point

The feed position is given by (X_f,Y_f) where X_f and Y_f are given be equations:

$$X_f = \frac{L}{2\sqrt{\epsilon_{reff}}}$$

and

$$Y_f = \frac{w}{2}$$

3.4. Ground Plane Dimension

The ground plane dimensions is given by

$L_g = 6h + L$

$W_g = 6h + W$

3.5. Antenna Dimensions

The designed parameters and its dimensions are given in table 1:

Table 1Antenna dimensions

Parameter	Dimension
Length	40mm
Width	30mm
X_f	20.39mm
Y_f	15mm
L_g	58mm
W_g	48mm

4. SIMULATION RESULTS

The antenna is designed using Ansoft HFS simulator and the designed antenna is shown in figure 3.

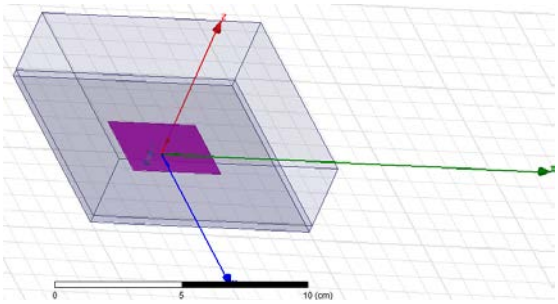

Figure 3: Design of Microstrip patch Antenna

4.1. Radiation Pattern

The radiation pattern obtained for the designed antenna is shown in figure 4:

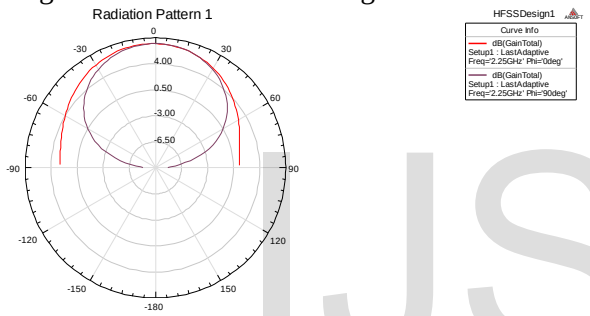

Figure 4: The radiation pattern for microstrip patch antenna

4.2. Rectangular Plot

The rectangular plot for the microstrip patch antenna is shown in figure 5. It shows that the designed antenna operates at a frequency of 2.36GHz.

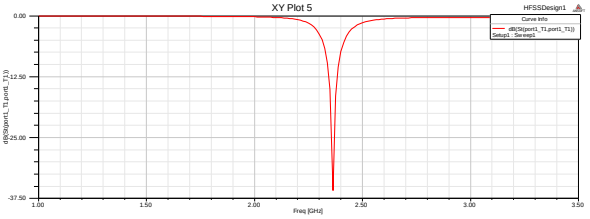

Figure 5: Rectangular plot of microstrip patch antenna

4.3. Polar Plot

The Polar plot for the microstrip patch antenna is shown in figure 6.

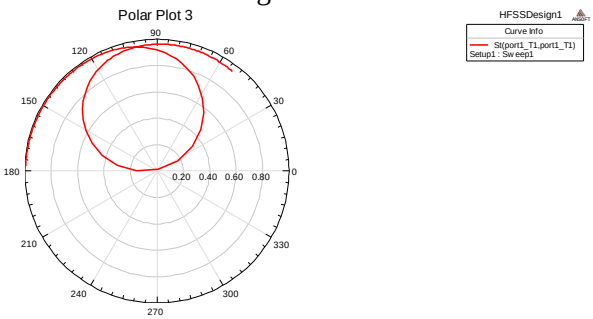

Figure 6: Polar plot of microstrip patch antenna

5. CONCLUSION

In this paper, the design of a rectangular patch antenna is presented that can operate at a frequency of 2.36GHz that can suits for S-band applications.

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