DESIGN AND ANALYSIS OF HIGHLY MINIATURIZED WIDE BAND PATCH ANTENNA

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ABSTRACT

Design and analysis of a highly miniaturized wide band patch antenna is implemented for small form factor (SFF) devices. A U-slot rectangular microstrip patch antenna that operates across different frequency bands with wide bandwidth of 125 GHz is implemented. The maximum achieved gain is 21.2 dB. The simple line feed technique used for the design of this antenna that makes this antenna a good choice in many communication systems in future. The antenna is fabricated on Rogers RO4350 board and its radiation characteristics are measured. However, these methods make antenna more complicated. A simple method to achieve the single (or) dual band characteristic in a microstrip antenna is embedding a patch on a rectangular substrate as a structure proposed in which the radiating patch includes a pair of step-patch. In microstrip antennas, embedded patch can also be used to enhance the impedance bandwidth of a single band antenna. A rectangular patch and a U-shaped patch have been investigated in order to broaden the bandwidth of a single band antenna.

Keywords*: Micro strip antenna, Miniature Antenna, Wide band antenna.*

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. Micro strip antenna technology began its rapid development in the late 1970s. By the early 1980s basic Micro strip antenna elements and arrays were fairly well establish in term of design and modeling. 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 Micro strip 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. Micro strip patch antennas radiate primarily because of the fringing fields between the patch edge and the ground plane. Therefore, non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a Micro strip line or probe feed. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the Micro strip line and the radiating patch this includes proximity feeding and aperture feeding. Micro strip 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 Micro strip resonant patches have been used extensively in many applications. In

this paper, the design of probe feed U-shaped rectangular Micro strip patch antenna for wide band applications is presented and is expected to operate within 50GHz - 60 GHz frequency span. This antenna is designed on a Rogers Duroid 5880 epoxy and its performance characteristics which include return loss, VSWR, and input impedance are obtained from the simulation.

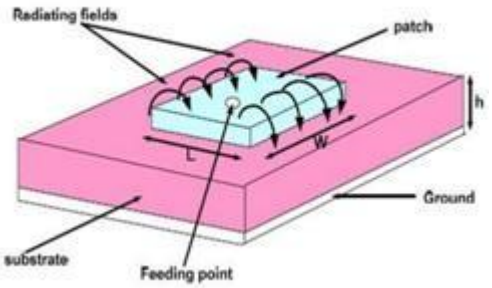

Figure 1: Micro strip patch Antenna

2. ANTENNA GEOMETRY

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

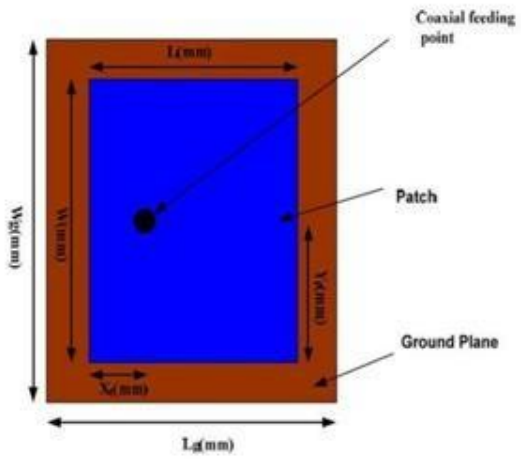

Figure 2: Dimensions of Rectangular patch Micro strip Antenna

For this patch, the length L of the patch is usually $0.3333\lambda < L < 0.5\lambda$, where λ is the free-space wavelength. The patch is selected to be very thin such that $t << \lambda$, where t is the patch thickness. The height h of the dielectric is usually $0.003\lambda <= h <= 0.05\lambda$. Thus, a rectangular patch of dimension 40.1mm×31mm is designed on one side of Rogers Droid 5880 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.

Width of the patch

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

$$W = \frac{C}{2f_0 \sqrt{\frac{\epsilon_r + 1}{2}}}$$

Length of the patch

Length of the patch is given by

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

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

Feed point

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

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

And

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

Ground Plane Dimension

The ground plane dimensions is given by

$L_g = 6h + L$

$W_g = 6h + W$

Antenna Dimensions

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

Table 1Antenna dimensions

Parameters	Dimensions
Length	10cm
Width	9cm
Thickness	0.32cm
X size	4cm
Y size	3cm

4. SIMULATION RESULTS

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

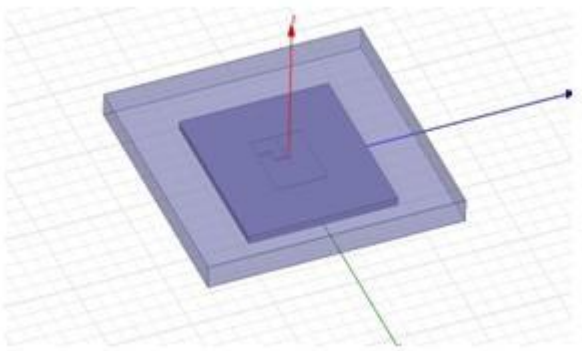

Figure 3: Design of U-Shaped Micro strip wide band patch Antenna

Radiation Pattern

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

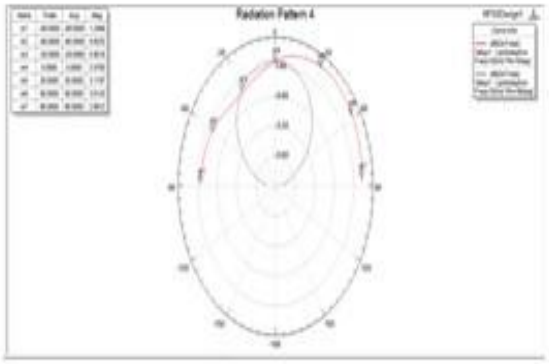

Figure 4: The radiation pattern for H-Shaped Micro strip patch antenna

Rectangular Plot

The rectangular plot for the micro strip patch antenna is shown in figure 5. It shows that the designed antenna operates at a frequency of 57.7GHz.

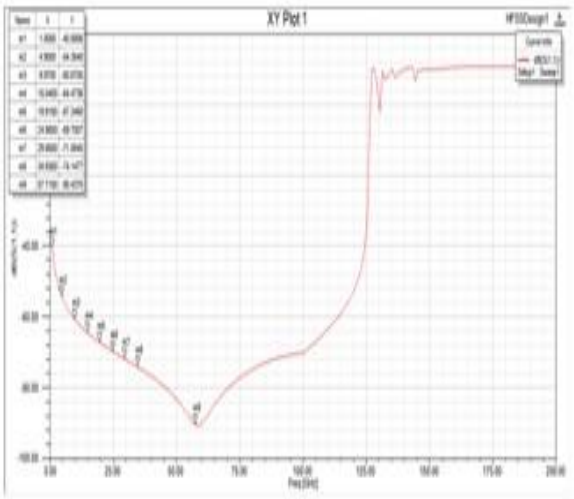

Figure 5: Rectangular plot of U-Shaped micro strip patch antenna

Comparison Table

The obtained parameters of the designed antenna are compared with various other antennas and the comparison results were furnished in table 2.

Table 2: Comparison Table

Antenna	Gain	Resonant frequency	Bandwidth
Rectangular patch antenna	1.8dB	4.81GHz	10GHz
Rectangular slot patch antenna	2.42dB	6.7GHz	10GHz
Modified u-slot antenna	21.2dB	57.7GHz	125GHz

5. CONCLUSION

A U-slot rectangular microstrip patch antenna that operates across different frequency bands with wide bandwidth of 125 GHz.The maximum achieved gain is dB . The simple feeding technique used for the design of this antenna that makes this antenna a good choice in many communication systems in future.

The designed antenna is verified for its performance using An soft HFSS simulator and various parameters have been obtained. Also the results have been compared with various other shaped patches like rectangular patch antenna and rectangular slot antenna.

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