DESIGN AND ANALYSIS OF MICROSTRIP PATCH ANTENNA WITH 2 HEXAGONAL SPLIT RING RESONATOR ARRAY FOR IOT APPLICATIONS

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ABSTRACT

Micro-strip patch antenna plays a major role in our day to day life. In this paper we designed a micro-strip patch antenna with a hexagonal split ring resonator for IOT applications. We used different measurements and arrays to calculate the parameters like return-loss and gain. All these are done using ANSOFT HFSS. The antenna is fabricated using FR-4 epoxy as substrate (relative permittivity=4.4, loss tangent=0.0004), and patch and the ground are copper (PEC) and a coaxial feed. These designed antennas are fabricated and used in real-time applications.

Keywords: Patch Antenna, HFSS, FR-4 epoxy

I. INTRODUCTION

Micro-strip patch antennas are widely used now a days because of several advantages like compact size, ease of fabrication, lower cost etc. A patch antenna is a narrowband and wide beam antenna fabricated by etching the element pattern of antenna in a metal trace bonded to an insulating dielectric substrate, such as printed circuit board, with a continuous layer of metal bonded to the opposite of the substrate which forms a ground plane.

A split-ring resonator (SRR) is an artificially produced structure common to metamaterials. Their purpose is to produce the desired magnetic susceptibility (magnetic response) in various types of metamaterials up to 200 terahertz. These media create the necessary strong magnetic coupling to an applied electromagnetic field, not otherwise available in conventional materials. For example, an effect such as negative permeability is produced with a periodic array of split ring resonators.

A single cell SRR has a pair of enclosed loops with splits in them at opposite ends. The loops are made of nonmagnetic metal like copper and have a small gap between them. The loops can be concentric, or square, and gapped as needed. A magnetic flux penetrating the metal rings will induce rotating currents in the rings, which produce their own flux to enhance or oppose the incident field (depending on the SRRs resonant properties). This field pattern is dipolar. The small gaps between the rings produces large capacitance values which lower the resonating frequency. Hence the dimensions of the structure are small compared to the resonant wavelength. This results in low radiative losses, and very high-quality factors.
Split ring resonators (SRRs) consist of a pair of concentric metallic rings, etched on a dielectric substrate, with slits etched on opposite sides. SRRs can produce an effect of being electrically smaller when responding to an oscillating electromagnetic field.

This paper reflects hexagonal split ring resonator patch antenna for IOT applications, Wimax applications.

II. ANTENNA GEOMETRY

The layout of the proposed hexagonal split ring resonator patch antenna is shown in fig1(a), 1(b),1(c)
III. DESIGN LAYOUT DESIGN PARAMETERS OF AN UNIT CELL

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>VALUES (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12.5</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
</tr>
<tr>
<td>C</td>
<td>7.5</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
</tr>
<tr>
<td>G</td>
<td>1</td>
</tr>
<tr>
<td>H</td>
<td>2</td>
</tr>
<tr>
<td>P</td>
<td>30</td>
</tr>
<tr>
<td>Q</td>
<td>30</td>
</tr>
</tbody>
</table>

IV. RESULTS:

The proposed antenna is designed in HFSS software and the results are simulated and verified. This antenna can be used at three different frequencies namely 3.2GHz, 5.2GHz, 4.54GHz. By creating 2X2 array and 4X4 array we calculate gain and found 2X2 have the highest gain and settled with it.

<table>
<thead>
<tr>
<th>ARRAY</th>
<th>GAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1X1</td>
<td>2.5dB</td>
</tr>
<tr>
<td>2X2</td>
<td>5dB</td>
</tr>
<tr>
<td>4X4</td>
<td>2.5dB</td>
</tr>
</tbody>
</table>

RETURNLOSS:

In this figure (d) the return loss at 3.2, 4.54GHz are -13.83, -9.8, -10.4199 respectively.
In This figure the return loss at 3.2, 4.5, 5.1 are -22.41, -10.23, -15.56 respectively.

In this figure the return loss at 3.2, 4.5, 5.1 are -24.71, -17.58, -15.28 respectively.

GAIN PLOT:

The 3D gain plot of 1X1 array, 2X2 array and 4X4 array is shown in below plots with maximum gain at resonant frequency.

The maximum gain from the figure 1g is 2.5dB.
1 (h) PLOT 2(2X2 ARRAY)
The maximum gain from the figure 1(h) is 5dB

1 (i) PLOT 3(3X3 ARRAY)
The maximum gain from the figure 1g is 2.5dB

VSWR PLOTS:
The given below plots are vswr plots for 1x1, 2x2, 4x4 Arrays respectively

Vswr plot for 1x1 array
V. COMPARISON AND ANALYSIS

<table>
<thead>
<tr>
<th>Array</th>
<th>Return Loss</th>
<th>Freq1</th>
<th>Freq2</th>
<th>Freq3</th>
<th>Gain(dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1x1</td>
<td>-14</td>
<td>3.24</td>
<td>4.54</td>
<td>5.2</td>
<td>2.5</td>
</tr>
<tr>
<td>2x2</td>
<td>-22.50</td>
<td>3.24</td>
<td>4.54</td>
<td>5.2</td>
<td>5</td>
</tr>
<tr>
<td>3x3</td>
<td>-24</td>
<td>3.24</td>
<td>4.54</td>
<td>5.2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

By observing the above tabular column, it is concluded that the designed antenna is resonates at 3 different frequencies which can be used for IOT applications. By comparing return loss and Gain of each antenna, it is concluded that 2X2 array is showing good agreement with return loss and gain.

VI. FABRICATED ANTENNA AND IT'S RESULTS:

The Designed antenna is fabricated for 2X2 array and results are verified practically. 2(a), 2(b), 2(c), 2(d) are the manufactured antenna and s11 plot and vswr plot respectively.
2(a) Fabricated antenna for 2X2 array

2(b) Fabricated antenna for 2X2 array

2(c) Measured return loss for 1X2 array hexagonal shape
Testing the antenna

2(d) Measured VSWR for 1X2 array hexagonal shape

The simulated results and measured results have good agreement with each other

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