Defected Ground Structure Printed Antenna with Triangular Slot

D. Shyam Prasad, Samiran Chatterjee

Abstract: Double Layer Single Feed dual resonant frequency patch antenna is presented in this paper. After design the patch, we are etched triangular and rectangular slots at the top and bottom layer of the patch. After design the antenna structure, we got a remarkable result and the operating frequencies are used for the various applications of microwave Communication. Two triangular slots are designed at the top layer from the both sides of the patch with one rectangular slot from the bottom layer and also one h-type slot is introduced at the middle portion from the rest at bottom layer to obtain the designed resonant frequency. The different shapes of the patch used to improve the gain bandwidth performance of the antenna. We get two operating frequencies for this triangular shaped printed antenna. 1st frequency is applicable for microwave radiometry from aircraft to measure ocean wind speed and rain characteristics in hurricanes and the other is used to design BeO POWER CHIP RESISTOR which is applicable for Microwave and RF high power communication, microwave amplifiers and power dividers. This paper includes an extensive analysis of simulated results for this above mentioned microstrip printed patch antenna. All results are simulated and verified by the network analyzer. Due to the basic characteristics of proposed printed antenna, it is suitable for the applications in long distance radio telecommunication systems. It is also applicable for satellite communication and microwave relay systems.

Keywords : Compact, Ground Plane, Layer and Feed, Operating Frequency, Slot.

I. INTRODUCTION

In the recent days of low power communication, the young engineers are search for such type of devices which is very handy, tiny, light weight and possibility of miniaturization. So, in this aspect the microstrip printed antenna is bring a positive interest to the engineers and especially who are willing to work in the microwave communication fields [1]. Due to the miniaturization of microwave devices, we use microstrip antenna for any types of communication irrespective of other devices. But in recent microwave and wireless communication, the engineers are required more than one resonant frequency due to the more coverage range for the communication. Requirements of two resonant frequency because most of young engineers are used multiple frequency bands for the communication and they want such type of device which can cover all the frequency. Due to this reason, the wireless engineers are designed antennas which are used for multiband operation with multiband characteristics. With the multiband characteristics, the other characteristics are to design the antenna in such a way which is consisting of the process of size reduction. It is one of the new techniques in which we cut different slots in the proper positions of usual antenna which is known by conventional antenna [2-5]. The meaning of size reduction is resonant frequency reduced by a large amount when compared to our usual antennas [6-12]. There are another some antennas are there which are same as patch antenna and the names are DRA (Dielectric Resonator Antenna) and Fractal Antenna [13-18]. But for designing the above mentioned two antennas, the engineers are facing some problems. Due to the requirement of high dielectric constant, DRA is not able to design, and fractal antennas structure is very complicated for design.

So, in recent days the compact printed antenna is smaller in size and also possible to miniature so, the young engineers are looking for the keen interest for this antenna and patch antennas demand are increased for the various communication especially for mobile and microwave communication [9-10]. The proposed work in this paper is presented by design of printed patch antenna which is combined with equal triangular slots which gave two operating frequencies. Designing of the proposed antenna in this paper is done due to etched two equal triangular slots on the both sides of the patch from top layer, one rectangular slot cut at the top from the bottom layer and also one h-type slot (Fig.-2) is introduced at the middle portion from the rest at bottom layer i.e. at ground plane for the improvement in return loss and performance of the antenna. We are used high value of dielectric constant in here for design of proposed antenna for the high percentage of size reduction [2-5]. The main aim is to design our proposed antenna with the increase of operating bandwidth and large increment of frequency ratio. We use the method of moment (MoM) based software [19] and the results are verified by using of Vector Network Analyzer. For the light weight, low cost and small size, the proposed antenna is applicable of satellite communication and related microwave relay systems.

II. ANTENNA STRUCTURE

Designed printed antenna configurations with PTFE substrate are shown in below figures. Two equal triangular slots (T1, T2) are cut both sides from edge of the patch at top layer is shown in figure-1. One rectangular slot cut at the top from the bottom layer and one h-type slot is introduced at the middle portion from the rest at bottom layer i.e. at ground plane is shown in figure-2. Dimensions and location of SMA connector which is used as a probe for designed antenna feeding point also displays in figure which radius is 0.8 mm.
The material is designed for our antenna is made with epoxy substrate whose dielectric constant is 1.6 mm. The co-axial probe with 0.8 mm radius is used at point (2,-3) considering the axis at X-Y plane (0,0). Figure-1 shows The top view of designed antenna is displays in Figure 1 and also and ground plane structure with same PTFE substrate displayed in Figure-2.

III. SIMULATED RESULTS AND ANALYSIS

Here, we are studying the sensitivity analysis of different geometric or physical parameters or both on the solution of the designed antenna and all the analysis of designed antenna are performed and designed here. Different analyses of parameter of designed antenna are discussed for improvement the performance of the antenna. Figure 3 displays the power loss of designed antenna.

For the insertion of slots in the proper position of the patch, the operating frequency is achieved with improved power loss with increased frequency ratio. We are achieved three resonant frequencies for the designed antenna with large return loss. The achieved frequency obtained at 4.59 GHz and 5.64 GHz with power loss of -20.29 dB and -12.46 dB with corresponding bandwidth of nearly 178.07 MHz and 169.91 MHz respectively.

The designed antenna is designed with same PTFE substrate with 40mm x 40 mm patch. The top layer of proposed antenna is designed exactly in the middle of the square patch i.e. 20mm x 20mm square patch.

III.1. Simulated radiation pattern

The following figures are displaying the simulated electric and magnetic power pattern of radiation for the designed antenna and that all patterns are measured and verified.
Now, with the following table we are combine all the results for are achievement for our designed antenna which is discussed under below:

**TABLE A:**

<table>
<thead>
<tr>
<th>Antenna Structure</th>
<th>Operating Frequency (GHz)</th>
<th>Ratio of Operating Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( f_1 = 4.59 )</td>
<td>214.89°</td>
</tr>
<tr>
<td></td>
<td>( f_2 = 5.64 )</td>
<td>323.84°</td>
</tr>
</tbody>
</table>

**TABLE II:**

<table>
<thead>
<tr>
<th>Antenna Structure</th>
<th>Operating Frequency (GHz)</th>
<th>Power Loss (dB)</th>
<th>10 dB Bandwidth (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( f_1 = 4.59 )</td>
<td>-20.29</td>
<td>178.07</td>
</tr>
<tr>
<td></td>
<td>( f_2 = 5.64 )</td>
<td>-12.46</td>
<td>169.91</td>
</tr>
</tbody>
</table>

**IV. EXPERIMENTAL RESULTS AND DISCUSSION**

The prototype models of designed antenna are displayed in Figure 9 and 10. After fabrication of antenna, we are tested the antenna results with network analyzer named Agilent N5230A.

After measuring all the results, we compare the results with software results and comparison of the result is displayed in Figure 11. The difference between the results is done for the soldering effect of SMA or tolerance problem of the substrate.
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V. CONCLUSION

Double Layer Single Feed dual resonant frequency patch antenna is presented in this paper. After design the patch, we are etched triangular and rectangular slots at the top and bottom layer of the patch. After design the antenna structure, we got a remarkable result and the operating frequencies are used for the various applications of microwave Communication. All the results are simulated by method of moment-based software and verified by network analyzer. Two triangular slots are designed at the top layer from the both sides of the patch with one rectangular slot from the bottom layer and also one h-type slot is introduced at the middle portion from the rest at bottom layer to obtain the desired resonant frequency achieved in power loss nearly -20.29 dB as well as in power delivered value nearly 1.21. Other observation is for designed antenna, the 3dB beam-width of the power pattern of radiation nearly 214.89° which is extremely large beam for the desired applications. Any change of feeding location the results also gives less bandwidth with fewer resonances.

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REFERENCES


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