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UWB CPW FED FRACTAL PATCH ANTENNA WITH BAND-NOTCHED FUNCTION EMPLOYING FOLDED T-SHAPED ELEMENT

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Abstract

An investigation of ultra-wide band coplanar waveguide fed antenna is presented consisting of a fractal radiating patch. The impedance match of the desired antenna is identified by the number of unit cells that are used in designing of the fractal patch by embedding the two rectangular patches in the ground plane. The impedance and bandwidth of the fractal radiating patch is improved which makes it suitable for the UWB applications. Geometry of proposed antenna is varied to obtain the antenna parameters which results in analyzing the performance of each modified antenna. Simulated results illustrate that the fabricated antenna exhibits required VSWR level, radiation characteristics and the return loss in the UWB frequency range. The antenna that is designed operates in the frequency range of 4-11GHz.The VSWR of the antenna is between 0-2 in the operating frequency of the antenna. The antenna measurements are 14x18x1mm3 respectively.

Keywords: Band-notch, coplanar waveguide (CPW)-fed, fractal, monopole antennas, ultrawideband (UWB) applications.

Introduction

The Ultra-wideband (UWB) technology has been in the prime focus as it uses very low Power for high data rate transmission. UWB technology provides new opportunities for various applications in the short range data applications where high precision is required. It occupies over a large portion in the radio spectrum and has a high bandwidth. In the year 2002 the Federal Communication Council (FCC) in United States has set its bandwidth in the range 3.1-10.6 GHz. The flexible nature, better ranging capabilities and robustness are some of the features of UWB technology. The narrow band antennas are replaced by the UWB antennas due to its better return loss over wide bandwidth, relatively low cost, ease of fabrication and easily integrated with latest communication terminals. The capability of antenna must be good enough to receive signals from all directions. One of the popular UWB antenna design includes the usage of rectangular ground planes which is required for the antenna to exhibit UWB performance [1-5].Fractal geometry has been specified in the year 1975 in order to design antennas with complex geometries. A small fractal cell can be designed which is scaled, moved and rotated resulting in different configurations of an antenna. The main attribute of fractal antenna is its self-similarity that represents the same characteristics with the whole structure. This geometry is widely used for designing of miniaturized antennas having physically smaller fractal elements [6-10].Several types of patch antennas have been implemented using various feed lines, such as micro strip line, coplanar waveguide and of different structural shapes, such as rectangular patch, triangular patch and circular patch etc. In this paper, a CPW-fed fractal patch antenna which has UWB features. The proposed antenna consists of trunk shaped patch on which an array of fractal unit cells is placed to resemble a tree like structure. The structure achieves return loss in the range which makes the antenna suitable for UWB applications. The analysis of antenna is done by subtracting the fractal branches from the ground plane and by adding the serrations to the branches. The return loss and VSWR plots of six models are presented. The antenna characteristics are analyzed and presented [11-12]. The current design is added up with some toothed elements on each edge of the fractal antenna. The research analysis shows that the serrations improve the characteristics of an antenna. [13-14].

2. Antenna Design and Geometry

The proposed antenna design consists of a FR4 dielectric substrate of thickness 1mm, relative permittivity of 4.4 and dielectric loss tangent of 0.024.The feed line has a width of Wt mm. The antenna consists of a radiating patch like a trunk for which an array of unit cells is placed to resemble a tree like structure. The antenna consists of two rectangles etched on either side of the feed line acting as ground planes. These two ground planes are responsible for the UWB performance of the antenna.

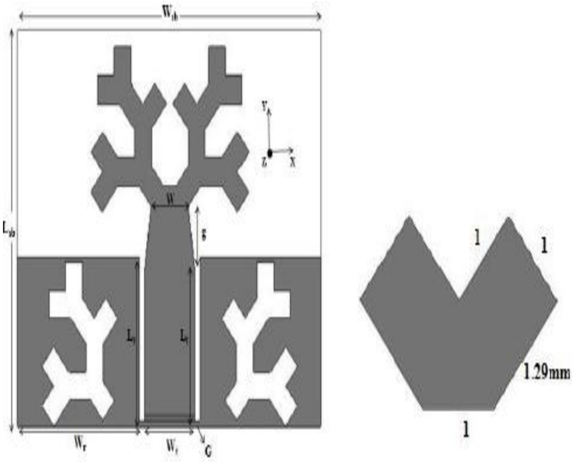

Figure 1. Configuration of proposed fractal antenna and its unit cell structure

The V-shaped unit cells are of dimensions as shown in Fig. 1. The patch is placed in between the two rectangular sheets with a gap of 0.3mm and the unit cells are placed accordingly on the patch. Eight unit cells are used in forming the tree structure of antenna. The CPW fed antenna has the feed line placed between the patch and ground plane with a length of 0.2 mm.The antenna works in the range 4-11 GHz. The VSWR is in between 0-2 within the operating range of the antenna.

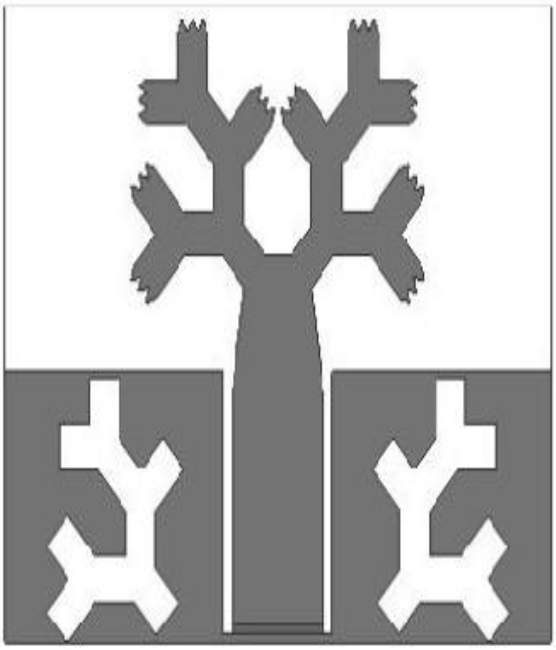

Figure 2. Proposed antenna after applying serrations.

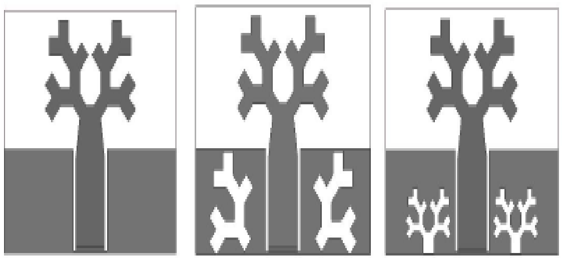

Figure 3. Geometry of fractal tree patch antennas.

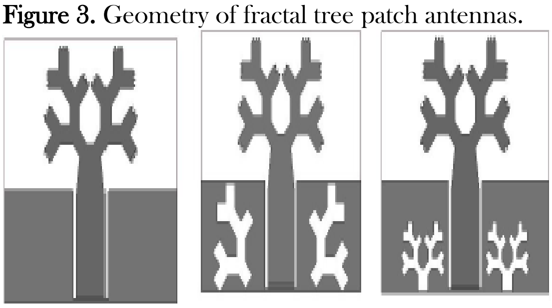

Figure 4. Geometry of serrated fractal tree patch antennas.

The second model has 2 side branches of the antenna subtracted from the rectangular sheets can be seen in Fig. 2. The operating frequency of the antenna changes from 6GHz to 9.7GHz where a narrow band is achieved. The bandwidth enhancement is observed by this modification. The third model has the entire branch subtracted from the ground plane. The dimensions of branch can be minimized by downscaling. The rest of the three models are designed by adding small triangular shaped structures as serrations to every edge of the branch shown in Fig. 4. The dimensions of the proposed antenna are tabulated as follows.

Table1. Antenna Parameters

Parameter	Dimension in mm	Parameter	Dimension in mm
W_{sb}	18	W_r	7.2
W_t	14	L_r	6
L_t	3	W	2.2
G	0.3	G	2.29

3. Results and Discussion

The proposed Fractal Antenna has been designed using 8 fractal unit cells using ANSYS HFSS. For all the six antennas, the parameters were discussed and the experimental results were presented. Model 1 resembles a fractal tree like structure. In model 2, two side branches are etched which results in minimum return loss compared to model 1 and model 3. For the proposed model, a larger band width of 7 GHz is achieved. For the first three antennas, the rectangular ground plane is modified and for the next three antennas models, serrations were added for analysis.

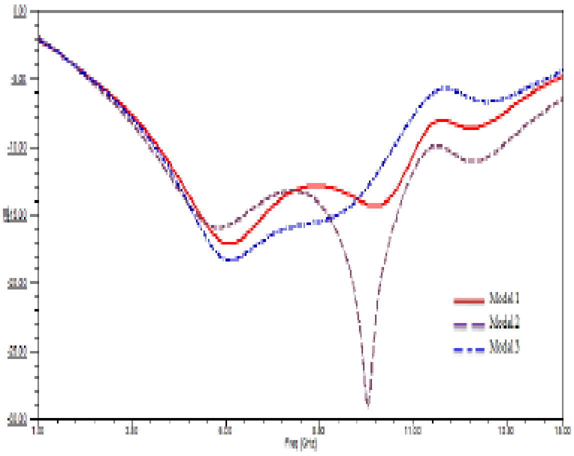

Figure 5. Return loss of non-serrated antennas

The dual band characteristics of antenna i.e., 4.03 GHz - 10.55GHz & 11.94GHz – 13.12GHz is observed for model 5.The better impedance matching is observed by the gap given between the ground plane and the patch. The subtraction of the single side branch from the ground plane has a very high effect on return loss of the antenna. The operating frequency is enhanced from 6 GHz to 9.7 GHz. the proposed model has the highest return loss of -29dB. Highest bandwidth is also observed for this model which is in the range of 3.96-11.52GHz. The VSWR for the non serrated antennas is observed to be almost same for the three antennas. The three serrated antennas have VSWR below 2 but for smaller range of frequency.

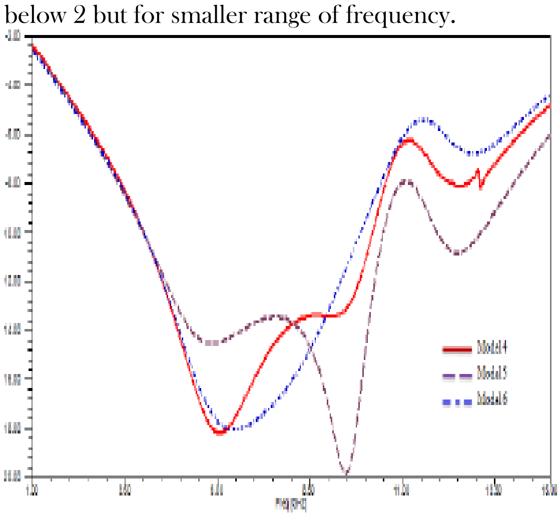

Figure 6. Return loss of serrated antennas

Standing wave Ratio (SWR) is one of the major constraints for antenna design. It requires exact match between the source and Transmission line. Thus VSWR should be as low as possible and the simulated results are shown in Fig. 8. The reflection coefficient for model 4, model 5 and model 6 are illustrated

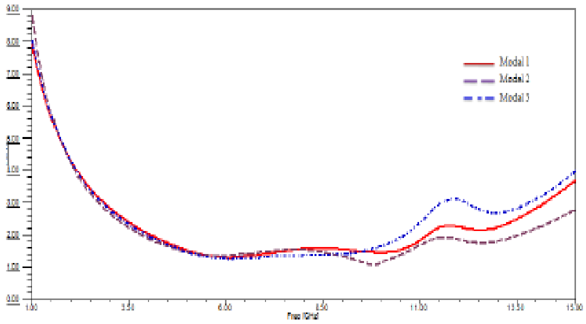

Figure 7. VSWR of non-serrated antennas

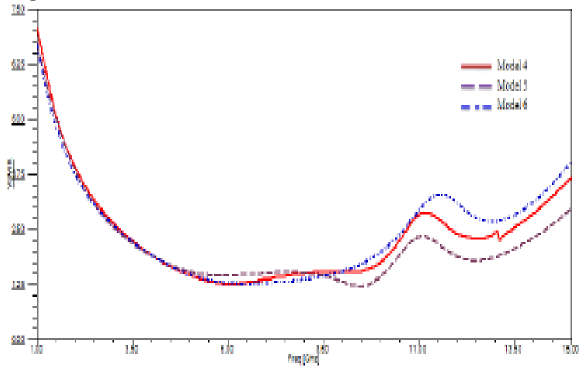

Figure 8. VSWR of serrated antennas

4. Conclusion

This paper describes a CPW-fed fractal patch antenna for the requirement of higher bandwidth and good VSWR. The rectangular ground planes are majorly required for the UWB performance. The subtraction of the side branches from the patch gives us the best return loss and the VSWR is observed to be almost same for all the modifications done to the proposed antenna within the operating frequency range. The antenna shows radiation pattern over the UWB

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