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Square Patch Antenna with Fractal DGS for Band Notch Function

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Abstract

In this article a simple and small size wideband square patch antenna has been examined for band notch characteristics. In order to broadening the band width of the simple patch antenna, the role of partial ground has been critically studied and analyzed. The presented methodology reveals that the implementation of meander line fractal shaped defected ground structure not only augment the band width of the antenna but also provide a notched band at 12.14 GHz required to reject the interference for existing wireless communication. A prototype of the proposed antenna has been fabricated to validate the simulated results. The measured and simulated results are in good agreement.

Keywords: Band Notch, DGS, Meander Line, Microstrip Patch Antenna

1. Introduction

Recent advancements in the communication systems throwing challenge of miniaturize and wide band antennas[1]. So far a lot of work has been reported in the literature for the broadening band width of microstrip patch antennas like slot loaded antennas[2], inverted F antennas[3], split ring monopole antenna[4], CPW fed microstrip antennas[5], tuning stub antennas, modified and perturbed fractal antennas. With the advantage of wider bandwidth these antennas possesses some disadvantages also like interference with the already existing wireless communications bands[6]. The rejection of this interference is of prime importance and attracting the attention of antenna design engineers these days[7]. In microstrip antennas these rejections can be easily handle by realizing its band notch property. Several attempts has already been made to explore the band notched behavior of the patch antennas such as by introduction of slot in the feed line, slots on the ground plane[8], defected ground structure and many more[9].

In the similar context, a small size, simple, wideband, rectangular patch antenna with band notch characteristics has been presented in this paper. A meander line fractal shaped defected ground structure has been utilized to obtain the notched band function covering 11.89 GHz to 12.50 GHz.

2. Design Consideration

The proposed antenna is illustrated in Figure 1. It is designed on a high-frequency FR4 substrate having dielectric constant of 4.4 with thickness of 1.6 mm, width of 20 mm and length of 20 mm. A 50Ω microstrip transmission line with width (W_p) of 5 mm is adopted to feed the radiating patch. In order to obtain maximum impedance matching over wider band, properties of partial ground plane in simple patch antenna has been explored efficiently. The side of the square patch, S is 10 mm and the length of the meander line fractal shaped defected ground structure, L_s is 4 mm. The DGS is placed exactly beneath the microstrip feed line for getting effective band notch characteristics.

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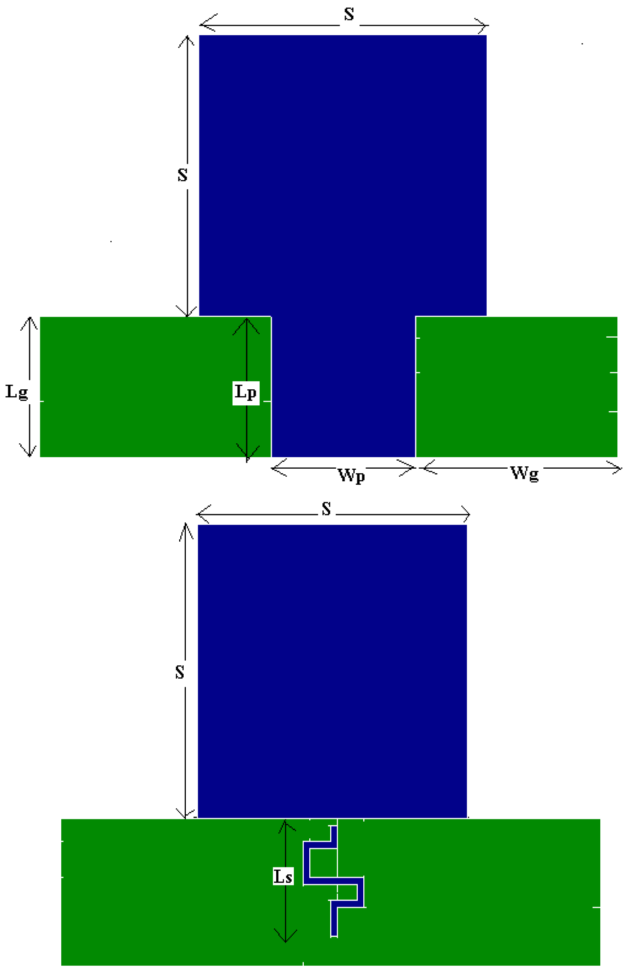


(a) (b)

Figure 1. Geometry of the proposed antenna (a) Top view (b) bottom view.

3. Results and Discussion

3.1 Resonating Characteristics

The proposed antenna has been analyzed using full wave electromagnetic simulator IE3D which is based on method of moment technique. Figure 2 illustrates the comparison of the simulated reflection coefficient of the band-notched antenna and the reference antenna. The partial ground plane is responsible for the wider bandwidth of the proposed antenna which covers the frequency band from 9.90 GHz to 13.36 GHz. Further the implementation of meander line fractal shaped defected ground structure exhibits a notched band function at 11.97 GHz covering frequency band from 11.79 GHz to 12.21 GHz. It is interesting to note that with the incorporation of DGS besides providing the notched band, it also increase the bandwidth of the proposed antenna. Furthermore, the band-notched characteristic can be easily tuned by means of adjusting the length and the width of the presented slot line.

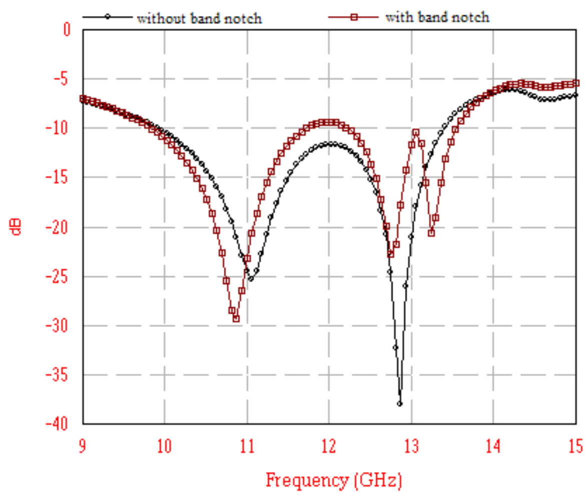
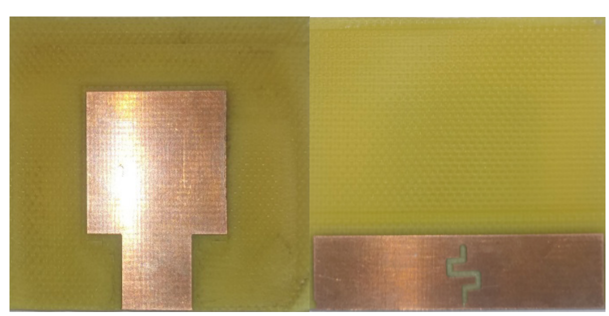


Figure 2. S[11] parameters of the proposed antenna with and without band notched characteristics.

3.2 Experimental Results

The proposed antenna has been fabricated in order to validate the simulated results. The photograph of the fabricated antenna is shown in Figure 3. The measured results show the good agreement with the simulated results. It may observed from the obtained measured results shown in Figure 4 that the proposed antenna possesses wider bandwidth in the range from 10.03 GHz to 13.70 GHz resonate at 10.99 GHz, 12.92 GHz and 13.40 GHz. It is also very clear from the figure that the antenna exhibits band notch function at center frequency of 12.14 GHz covering frequency band from 10.03 GHz to 13.70 GHz.



(a) (b)

Figure 3. Photograph of the fabricated antenna (a) Top view (b) bottom view. adiation Patterns

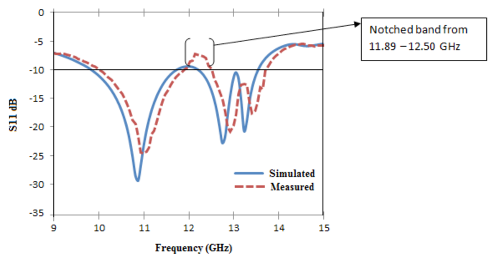
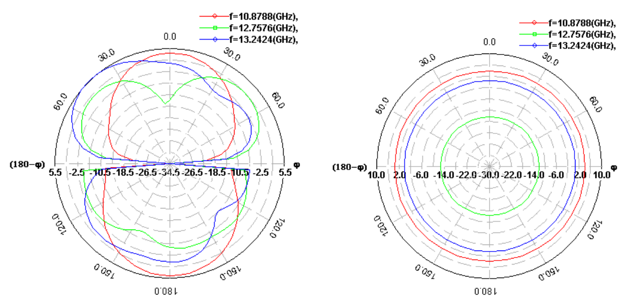


Figure 4. Comparison of measured and simulated S[11] parameters of the proposed antenna.

3.3 Radiation Patterns

The radiation patterns for both E- and H-planes of the proposed antenna at simulated resonating frequencies 10.88 GHz, 12.76 GHz and 13.24 GHZ are shown in Figure 5. As can be observed, the radiation pattern can be said normal to the radiating patch. The pattern in H-plane is omni directional and it is more like a dipole patterns in E-plane.



(a) (b)

Figure 5. Simulated radiation patterns of proposed antenna (a) E-plane, (b) H-plane.

3.4 Gain

The maximum gain of the proposed antenna is plotted and shown in Figure 6. It is clearly visible that for the proposed antenna with band notch characteristics exhibits maximum gain of 5.21 dBi at resonating frequency of 10.88 GHz.

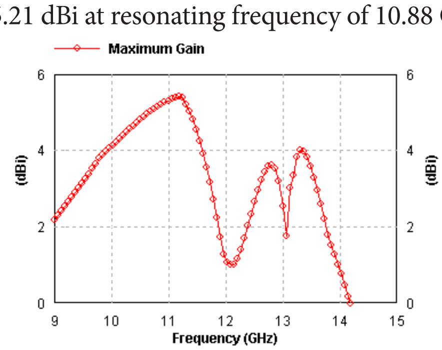


Figure 6. Simulated gain of the proposed antenna.

4. Conclusion

In this paper an attempt has been made to design a small size square patch antenna for wide band application. The analysis of partial ground plane indicates the property of broadening of bandwidth in microstrip patch antennas. Further the incorporation of meander line fractal shaped defected ground structure generate the notched band at 12.14 GHz. A prototype for the result validations has been built and found good agreement between simulated and measured results. All of these results indicate that the proposed antenna has good band-notched characteristics and effectively minimizes the potential interferences between wideband systems and narrowband wireless systems.

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