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Fractaled Parasitic Element Strip Antenna Having 1.5 To 2.6 GHz Band with Beveled Shaped Ground Plane

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Abstract: - A new antenna structure comprising of multiple strips having rectangular shape fractal in center parasitic element and beveled shaped ground plane for ultra-wideband applications is presented in this research paper. The proposed antenna consists of a beveled shape ground plane with rectangular shaped strip on radiating plane. Its simulated result displays impedance bandwidth from 1.5 GHz to 2.6 GHz. The antenna complies with the return loss of S11 < –10 dB and Voltage Standing Wave Ratio (VSWR) < 2 throughout the impedance bandwidth. This antenna has surpassed the bandwidth of UWB requirement, which is from 1.5 GHz to 2.6 GHz, and exhibits good UWB characteristics.

Keywords: **Ultra Wideband (UWB), Return Loss, Impedance Bandwidth, Voltage Standing Wave Ratio (VSWR).**

I. INTRODUCTION

Ultra Wideband (UWB) utilizes narrow pulses (on the order of a few nanoseconds or less) for sensing and communication. In India 3G mobile applications are utilizing 1.7 to 2.2 GHz band for communication purpose [1]. The concept of microstrip antenna dates back to the 1950's, but it was not until the 1970's that greater emphasis was given to develop this technology. This is mainly due to the availability of good substrates. Since then, extensive research and development of microstrip antenna and arrays, exploiting the numerous advantages such as light weight, low volume, low cost, planar configuration, compatibility with integrated circuits, have led to diversified applications and to the establishment of the topic as a separate entity within the broad field of microwave antennas [2]. Many UWB microstrip patch antennas have been discussed in the literature to achieve the requirement for different applications, one of which to increase the bandwidth. Since microstrip patch antennas inherently have narrow bandwidth characteristic, there have been numerous techniques developed for bandwidth enhancement in order to achieve the UWB characteristics. These antennas have been discussed in the literature, for instance, square-ring slot antenna [4], U-slot patch antennas [5], dual-band slotted antenna [6], right-angle modified Uslot antenna [7], ice cream cone antenna [8], E-shaped patch antenna [9] and dual-band notched antenna [10]. Other techniques employed to increase the bandwidth of antennas include meandered ground plane [11], slot loading [12], and electromagnetically coupled stacked patch [13]. In this paper, the fractaled parasitic element microstrip antenna which operates in the range of 1.5 – 2.6 GHz is presented, thus the UWB bandwidth enhancement is achieved. The parameters which affect the operation of the antenna in terms of its frequency domain characteristics are analyzed numerically and simulated with IE3D in order to understand the operation of the antenna. Section 2 describes the basic configuration of the antenna design, whereas Section 3 discusses simulated results of the antenna performances. Lastly, the findings of the simulated and measure results are summarized in the conclusion.

II. BASIC CONFIGURATION

Figure 1 illustrates the basic configuration of the antenna design. The antenna is designed on an FR4 substrate with the thickness of 1.6 mm and dielectric constant of 4.4. The antenna consists of patch with five rectangular shaped strips of reducing length; center strip is rectangular stair shaped fractal with length 16 mm and width of 4 mm a smaller patch which serves as the feed line and a partial ground plane. On the front side (radiating plane) a rectangular shaped patch having width W_{Patch} and length LR_{Patch}. With parasitic elements of same width but reducing length are placed. The proposed antenna, which is shown in Figure 1, printed on a FR4 substrate of thickness 1.6 mm, permittivity 4.4 and loss tangent 0.02. On the ground plane side of the substrate, a beveled shape square patch of length L_{Patch} is drawn with a cut-slop of S_{Patch}. On the front side (radiating plane) a rectangular shaped patch having width W_{Patch} and length LR_{Patch}. With parasitic elements of same width but reducing length are placed. In general, the length of monopole antenna (L_{Patch}) is usually about a quarter-wavelength, thus the lowest operating frequency can be empirically approximated by [2]

$$F_l \cong \frac{C}{\sqrt{\epsilon_{eff}} X 4 L_{Patch}}$$

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2}$$

Where c is the speed of light, and ε_r is the approximated effective dielectric constant [8].

Table I Optimized Value of Each Parameter

Parameter	Value in mm	Description
L_{Patch}	30 mm	Length of side of Square Patch

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S_{Patch}	7.75 mm	Length of Cut-Slope at corner of Ground patch
W_{Patch}	4 mm	Width of radiating patch side Strip Line
LR_{Patch}	11 mm	Length of radiating patch side Strip Line
L_{frac}	8mm	Length of fractal
W_{frac}	2mm	Width of fractal

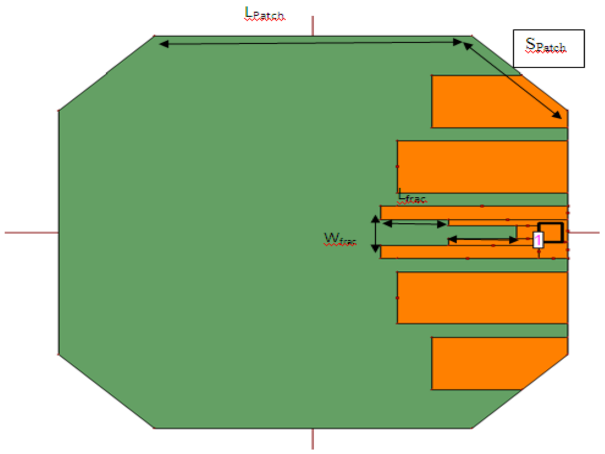


Figure – 1

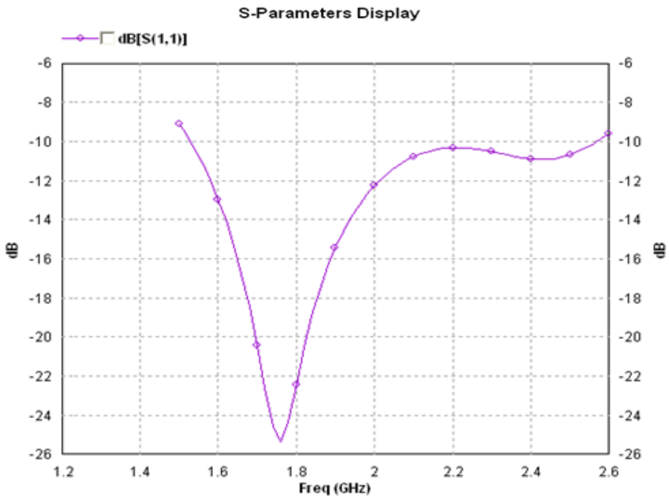


Figure – 2 S-Parameter of Fig -1 Geometry

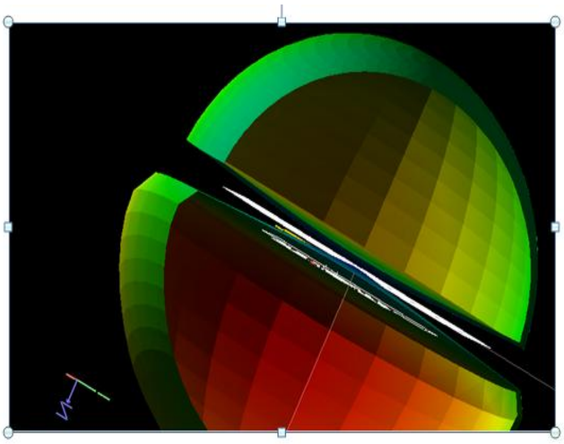


Figure -3 3D Radiation Pattern Display of Fig-1 Geometry

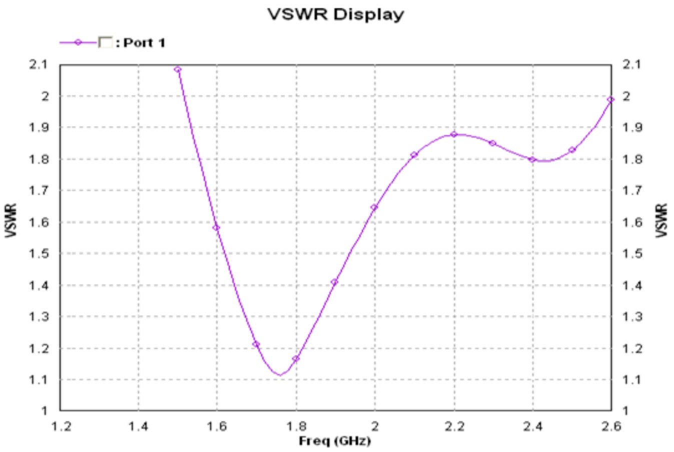


Figure -4 VSWR Display of Fig-1 Geometry

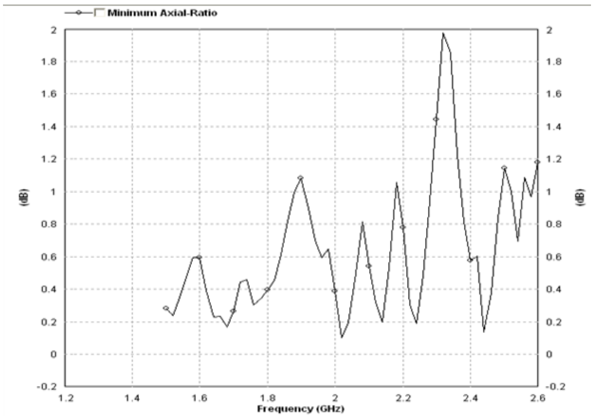
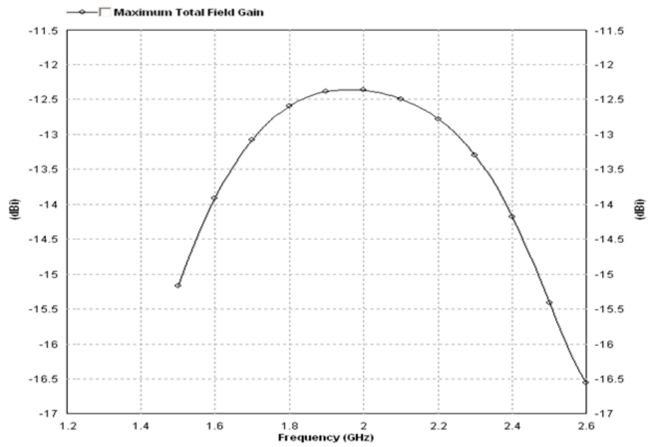


Figure – 5 Graph of Axial Ratio



III. RESULT AND DISCUSSION

In this presented paper a planar antenna with various design parameters is constructed, and the numerical results are presented and discussed. The parameters of this proposed antenna are studied by changing one parameter at a time and fixing the others. The simulated results are obtained using IE3D simulator. The optimized values of each physical dimension of the proposed antenna are shown in Fig. 1 and Table 1. To minimize the physical size of the proposed UWB antenna and increase the impedance bandwidth, a tilted cut-slope is introduced into the ground plane to alter the input impedance characteristics. Fig. 2 shows the return loss of the presented antenna geometry. As it is shown in figurre-1 that return loss is less than -10DB for the frequency range between 1.5 GHz to 2.6 GHz, i.e. value of return loss remained in favorable range for total 1.1 GHz with center frequency at 2.05 GHz. So the bandwidth of present antenna is 54% of center frequency which comes in ultra wide band range. 3D radiation pattern VSWR, Axial Ratio, and Maximum gains for presented antenna are shown in Figure 3-6.

IV. FUTURE SCOPE

The gain of presented antenna remains in negative region of dB scale, which could be a value for optimization in future.

REFERENCES

[1] Chia Ping Lee, Chandan Kumar Chakrabarty, "Ultra Wideband Microstrip Diamond Slotted Patch Antenna with Enhanced Bandwidth", Int. J. Communications, Network and System Sciences, 2011, 4, 468-474

[2] C. A Balanis, "Antenna Theory Analysis and Design, 2nd Edition", John Wiley & Sons, New York, 1996.

[3] R. Movahedinia, M.N. Azarmanesh,:" Ultra-wideband band-notched printed monopole antenna", IET Microw. Antennas Propag. 2010, Vol. 4, Iss. 12, pp. 2179–2186, ISSN 1751-8725

[4] MOVAHEDINIA R., AZARMANESH M.N.: 'A novel planar UWB monopole antenna with variable frequency band-notch function based on etched slot-type ELC on the patch', Microw. Opt. Tech. Lett., 2010, 52, (1), pp. 229–232

[5] G. Z. Rafi and L. Shafai, "Wideband V-Slotted Diamond-Shaped Microstrip Patch Antenna," Electronics Letters, Vol. 40, No. 19, 2004, pp. 1166-1167.

[6] Y. Zehforoosh, C. Ghobadi and J. Nourinia, "Antenna design for Ultra Wideband Application Using a New Multilayer Structure," Progress in Electromagnetic Research Symposium, Beijing, 26-30 March 2007

[7] S. Sadat, M. Fardis, F. Geran, G. Dadashzadeh, N. Hojjat and M. Roshandel, "A Compact Microstrip Square-Ring Slot Antenna for UWB Applications," IEEE Antennas and Propagation Society International Symposium, 9-14 July 2006, pp. 4629-4632.

[8] K. F. Lee, K. M. Luk, K. F. Tong, S. M. Shum, T. Huynk and R. Q. Lee, "Experimental and Simulation Studies of the Coaxially Fed U-slot Rectangular Patch" IEEE Proceedings of Microwave Antenna Propagation, Vol. 144, No. 5, October 1997, pp. 354-358.

[9] CHUNG K., HONG S., CHOI J.: 'Ultra wide-band printed monopole antenna with band-notch filters', IET Microw. Antennas Propag., 2007, 1, (2), pp. 518–522

[10] WU Q., JIN R., DING M.: 'Printed omni-directional UWB monopole antenna with very compact size', IEEE Trans. Antennas Propag., 2008, 56, (3), pp. 896–899

[11] ELDEK A.A.: 'Numerical analysis of a small ultra wideband microstrip-fed tap monopole antenna', Progr. Electromagn. Res., 2006, PIER, 65, pp. 59–69

[12] CHUNG K., HONG S., CHOI J.: 'Ultra wide-band printed monopole antenna with band-notch filters', IET Microw. Antennas Propag., 2007, 1, (2), pp. 518–522

[13] MA T.-G., WU S.-J.: 'Ultra wideband band-notched folded strip monopole antenna', IEEE Trans. Antennas Propag., 2007, 55, (9), pp. 2473–2479

[14] ZAKER R., GHOBADI C.H., NOURINIA J.: 'Bandwidth enhancement of novel compact single and dual band notched printed monopole antenna with a pair of L-shaped slots', IEEE Trans. Antennas Propag., 2009, 57, (12), pp. 3978–3983