Modified Edged Microstrip Square Patch Antenna With Square Fractal Slots for Bluetooth Applications.

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Abstract— **The present work deals with the designing of a microstrip square patch antenna with modified edges and square fractal slots for Bluetooth applications. Since microstrip antennas lack a broad bandwidth, the present technique has been used as an alternative solution to increase the bandwidth. The proposed antenna has an impedance bandwidth of 30% around the resonant frequency of 2.45GHz. This antenna has been simulated through IE3D simulation software based on method of moments.**

Keywords— Bandwidth; Bluetooth; Fractal Slots; IE3D; Microstrip Patch Antenna.

I. Introduction

Bluetooth is a wireless technology that enables us to exchange data over short distances within a frequency range of 2400-2485MHz [1,2,3,4]. However the major limitations in wireless communication applications are size, weight and ease of installation of antennas. These constraints can be overcome by using microstrip patch antennas which are light in weight, compact, conformal shaped, highly efficient, easily integrated to circuits and cost-effective [5]. However, conventional microstrip patch antennas suffer from very narrow bandwidth, typically about 5% bandwidth with respect to central frequency.

Various techniques that have been used to increase the bandwidth of antennas include increasing the thickness of substrate, using low dielectric substrate, using multiple resonators and applying slot antenna geometry. Yogesh [6] demonstrated that a V-shaped slot on triangular patch antenna has an impedance bandwidth of 9.2%. M.N. Shakib [7] designed a W-shaped microstrip patch antenna which exhibits an impedance bandwidth of 20.79%. Aneesh [2] proposed an S-shaped microstrip patch antenna for Bluetooth applications that achieved an impedance bandwidth of 21.62%. Several other techniques have been developed for bandwidth enhancement, for instance, inverted and non-inverted V-shaped slotted trapezoidal patch antennas[8], square-ring slot antenna[9], U-slot rectangular patch antenna[10], ice-cream cone antenna[11], right-angle modified U-slot antenna [12] and patch antennas with sierpinski and crown square fractal shaped slots[13,14].

This paper elaborates the design of a square patch antenna with modified edges and square fractal slots which operates in the frequency range of 2.19-2.95GHz i.e. 30% around the center frequency of 2.45GHz.

II. Fractal Slots

The term fractal refers to broken or irregular fragments. Fractals are usually made up of multiple copies of themselves at different scales. Thus they do not have a predefined size. This makes their use in designing of antenna favorable. Fractals possess some unique features such as self-similarity and space-filling property [15]. A self-similar set can be defined as a set that contains scaled down copies of itself. This self-similar property leads to multiband characteristics of antenna whereas the space-filling property leads to miniaturization of antenna as the order of iteration increases. Thus antennas using fractal slots generally exhibit suitable qualities like compact size, low profile, conformal shape and multiband or broadband operation.

III. Coaxial Feed

Co-axial or probe feed [5] is a very common technique for feeding microstrip patch antennas. As shown in Fig.1, the inner conductor of the co-axial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor remains connected to the ground plane. The major benefit of probe feed is that it can be applied at any desired location inside the patch for impedance matching. This feed method is easy to fabricate and has low spurious radiation.

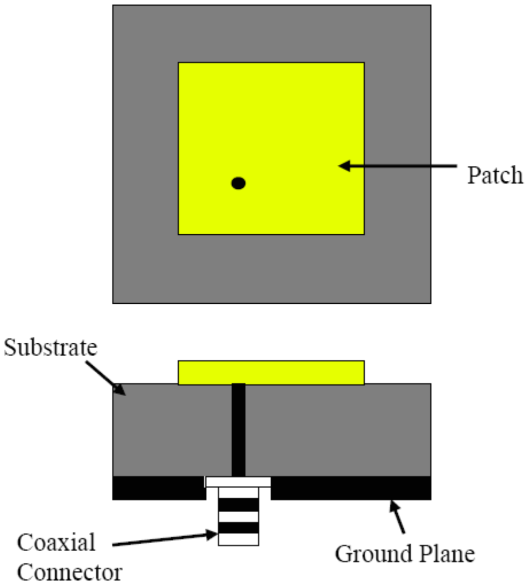

Fig.1. Probe fed Microstrip patch antenna

IV. DESCRIPTION OF THE PROPOSED ANTENNA DESIGN

Fig.2 illustrates the basic configuration of the proposed antenna design. This antenna is designed on an FR4 substrate with dielectric constant of 4.4 and thickness of 1.6mm. The square microstrip patch has a side length of L_p= 28mm and finite ground plane length of L_g=38mm. Portions of corners of square patch have been truncated to produce modified edges as shown in the figure. A square fractal slot of 4x4mm has been cut at the centre and four 2x2mm square fractal slots are taken on each corner of the central slot. In this work, co-axial or probe feed technique has been used as its main advantage is that the feed can be placed at any point in the patch to match with its input impedance.

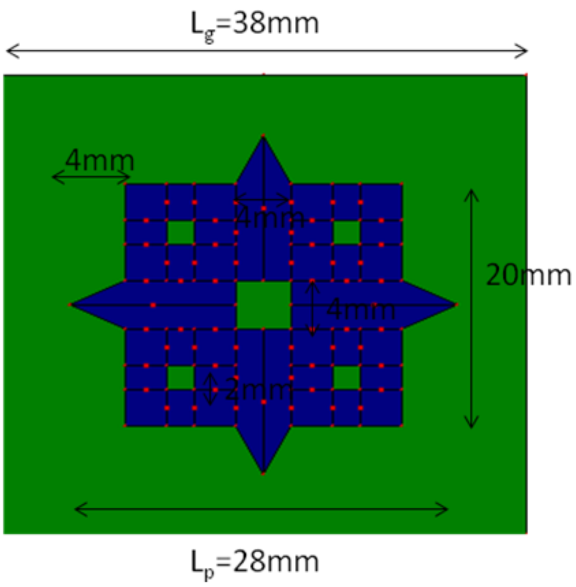

Fig.2. Geometry of the proposed microstrip antenna

The software used to model and simulate the antenna is IE3D simulation software. It has been used to compute and plot return loss, VSWR, smith chart, radiation pattern, gain and various other parameters.

V. RESULTS AND DISCUSSIONS

The intended antenna has been stimulated using IE3D simulation software [16]. Fig.3 shows the variation of return loss with frequency. The plot displays a total available impedance bandwidth from 2.19-2.95GHz i.e. 30% around the resonant frequency of 2.45GHz. Minimum return loss of -35.09dB is available at resonant frequency which is significant. Fig.4 shows the VSWR plot with a noticeable VSWR of 1.036 at 2.45GHz. Fig.5 throws light on the relationship between gain and frequency. In this paper a gain of 3.274dBi has been obtained at resonant frequency. Fig.6 demonstrates the input impedance loci using smith chart. Fig.7 shows the 2D radiation pattern of gain of the suggested antenna as a function of phi. This pattern contains two major lobes in opposite directions and is thus bidirectional in nature. Fig.8 demonstrates the 2D radiation pattern of gain as a function of theta. This pattern too is bidirectional.

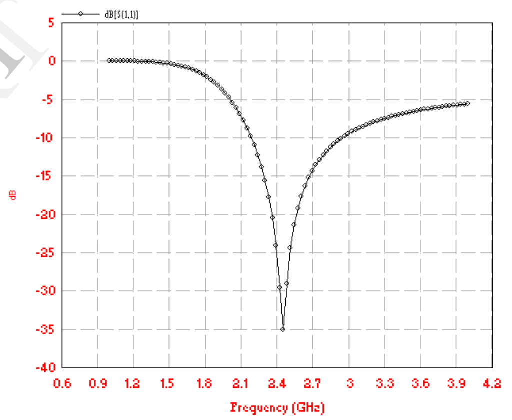

Fig.3. Return loss v/s frequency graph

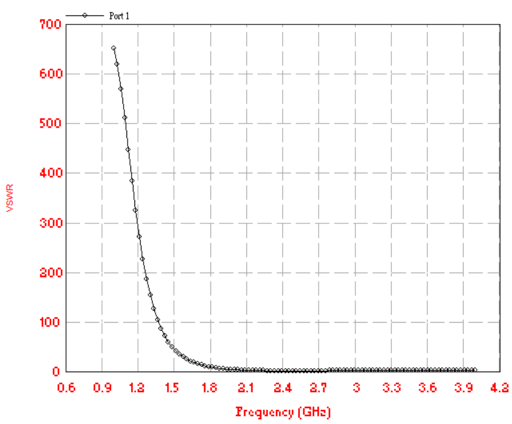

Fig.4. VSWR of the proposed antenna

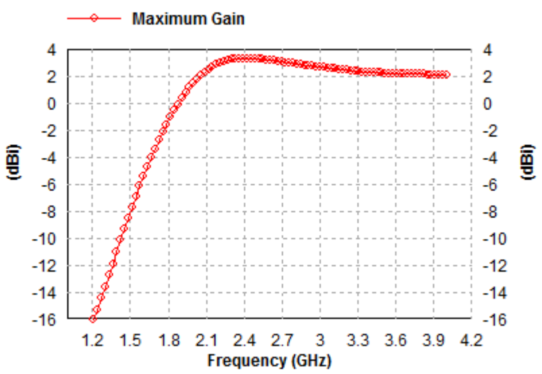

Fig.5. Gain vs. frequency plot.

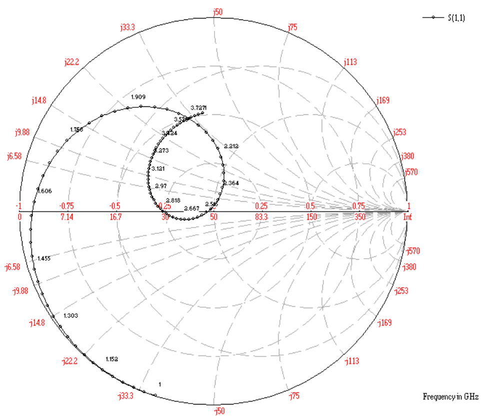

Fig.6. Smith chart of the proposed antenna.

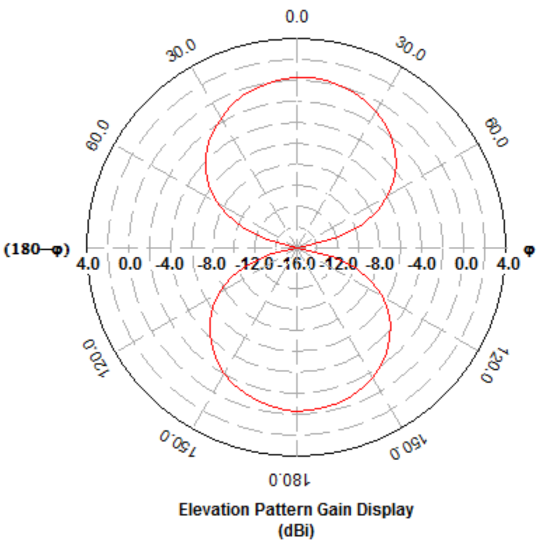

Fig.7. 2D Radiation Pattern of Gain along phi

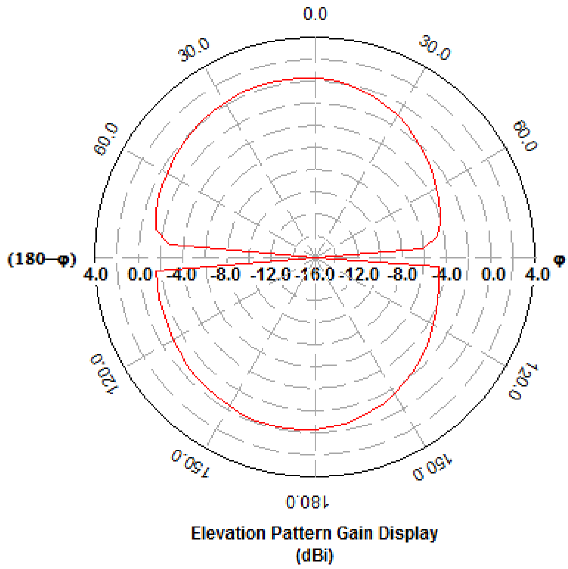

Fig.8. 2D Radiation Pattern of Gain along theta

VI. CONCLUSION

In this paper a probe fed microstrip square patch antenna has been designed at 2.45GHz. This antenna holds a promising future in Bluetooth applications as the intended design utilizes the entire frequency range of 2.4-2.48GHz. The proposed antenna has an impedance bandwidth of 30%, VSWR of 1.036 and radiation efficiency of 96.39%, which are notable results.

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