KOCH FRACTAL ANTENNAS WITH COPLANAR CAPACITIVE FEED

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ABSTRACT

In this paper, design of a coplanar microstrip Fractal antenna with coplanar capacitive coupled probe fed, for wide band frequency operation is presented. The proposed antenna is excited by a single probe feed connected to a capacitive feed strip placed at the centre of the fractal antenna. The coplanar capacitive feed strip is modified to obtain the best possible match with the antenna input impedance and to tune out the excessive capacitive reactance due to feed strip. It is demonstrated that the modified feed strip, placed in the circular hole inside the fractal antenna and similar radiation characteristics can be obtained at the band of frequencies. Iteration of Koch dimensions decides the resonant frequency band values.

Key Word: Capacitive feed, Fractal, Koch, Wide band antenna

I. INTRODUCTION

Microstrip antennas are versatile candidates for the modern wireless applications because of their numerous advantages [5,6]. Microstrip patch fractal antennas have been rapidly developed for multi-band and broad band in high data rate systems known as wideband communication systems. The use of microstrip fractal geometry antennas in electromagnetic radiations has been a recent topic of interest in the world. It has been shown that fractal shaped antennas exhibit features that are directly associated with the geometric properties of fractals. One property associated with fractal geometry that is used in the design of super special antennas is self-similarity, which means that some of their parts have the same shape as the whole object but at a different scale [1,3]. The construction of many ideal fractal. Another advantage of ring antenna is that it offers wide bandwidth and high radiation resistance when it is excited to operate at higher order modes [6].

There are several microstrip patch/ring antennas have been reported in literature which operate at dual resonant frequencies [2]. However, many of these have relatively complex assembly like stacked configuration [3], suspended configuration (with air gap) [3], modified ground shape [4], dual feed [2] etc., which in some cases is contrary to the fundamental attraction of microstrip antennas. On the other hand antenna reported in uses modified probe feed which requires precise alignment. In this work, a design that uses single layer (no air gap and stacked dielectric substrates) and single feed, which offers a wide band frequency operation is proposed.

II. FRACTAL GEOMETRY

Fractals are not just complex shapes and pretty pictures generated by computers. Anything that appears random and irregular can be a fractal. Fractals permeate our lives, appearing in places as tiny as the membrane of a cell and as majestic as the solar system. Fractals are the unique, irregular patterns left behind by the unpredictable movements of the chaotic world at work. In theory, one can argue that everything existent on this world is a fractal.

A wide variety of applications of fractals can be found in many branches of science and engineering. One such area is fractal electrodynamics. Fractal geometry can be combined with the electromagnetic theory for the purpose of investigating a new class of radiation, propagation and scattering problems.

III. FRACTAL AS A MAINITURE TECHNIQUE

Small antennas are of prime importance because of the available space limitation on devices and the on-coming deployment of diversity and multi-input multi- output (MIMO) systems. The basic antenna miniaturization techniques can be summarized into lumped-element loading, material loading, and use of ground planes, short circuits, the antenna environment and finally the antenna geometry.

Fractal geometry provides the solution by designing compact and multiband antennas in a most efficient and sophisticated way. In the miniaturization of wire antennas it has been found that the electromagnetic coupling between wire angles limits the reduction of the resonant frequency with increasing wire length.

IV. KOCH FRACTAL ANTENNAS OPTIMIZATION WITH CAPACITIVE FEED STRIP

It should be noted though applying fractal geometry to reduce the size of the wire antenna a reduction in resonant frequency is obtained. The effect can be explained with the help of Koch fractal curve to understand the behavior of the resonant frequency of fractal antennas as a function of the antenna geometry and wire length. It has been found that with increase in number of iterations, n, the effective length increases by a factor of $(4 / 3)^n$. Thus with an increase of the wire length of a Koch fractal there is a decrease in the resonant frequency. The observed behavior can be further explained due to the coupling fact between the sharp angles at curve segment junctions as shown in Figures 3.1 and 3.2. These angles radiate a spherical wave with phase center at the vertex. Each angle not only radiates, but also receives the signal radiated by other angles. As a consequence, part of the signal does not follow the wire path, but takes shortcuts that start at a radiating angle. The length of the path traveled by the signal is, therefore, shorter than the total wire length. The degree of coupling between parallel wire segments with opposite current vectors causes a significant reduction in the effective length of the total wire, and therefore an increase in the resonant frequency.

Fig: The Four Segments that form the basis of the Koch Fractal Antenna

When used as wire antenna the fractal antennas leads to more effective coupling of energy from feeding transmission lines to free space in less volume. Similarly when used as loop antennas, the fractal antennas with increased length it raises the input resistance of a loop antenna The Koch curve has been used to construct a monopole and a dipole in order to reduce antenna size. The miniaturization of the antennas shows a greater degree of effectiveness for the first several iterations. From the properties of the Koch fractal monopole it was shown that the electrical performance of Koch fractal monopoles is superior to that of conventional straight wire monopoles, especially when operated in the small-antenna frequency regime.

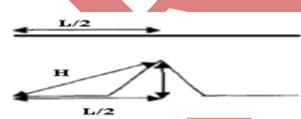
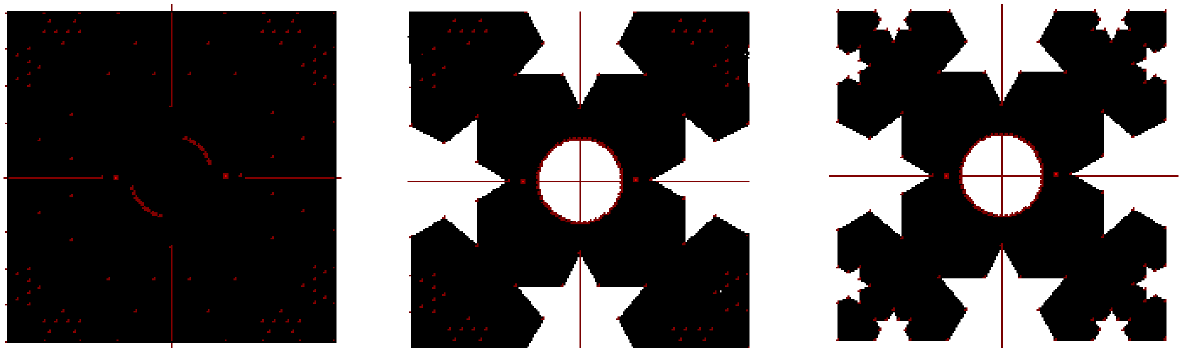


Figure. Calculation of the distance R

III. BASIC ANTENNA GEOMETRY AND ITS WORKING

The basic geometry of the antenna with a coplanar capacitive feed strip is shown in Figure 1. The radiating koch along with the capacitive feed strip is located on the same substrate. Here the feed strip is fed by the coaxial probe which is coupled to the fractal radiator by capacitive means. It can be recalled that the feed microstrip edges introduce inductive reactance, which can be used to effectively tune out the capacitive reactance offered by the feed strip. The geometry of the fractal antenna with the feed strip is shown in Figure.

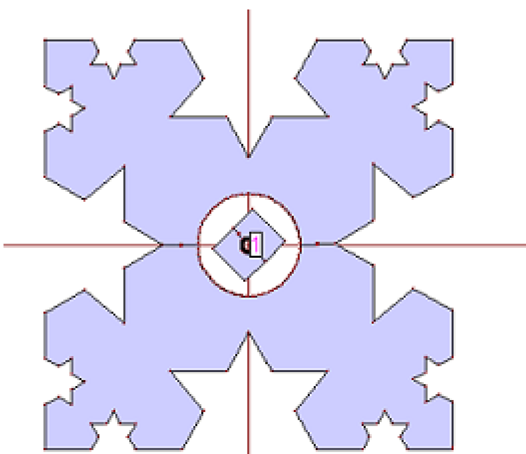
h = 1.52 mm, er = 3.38, Wx L = 40 mm X 40 mm



The Koch shaped fractal antenna has been designed on the substrate with dielectric constant 3.38 and thickness h = 1.52 mm. First the conventional

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

Design procedure and simulation of the proposed antenna is carried out by IE3D, which is method of moment based tool. The measured impedance bandwidth of the optimized antenna is approximately 28% (12-17 GHz).



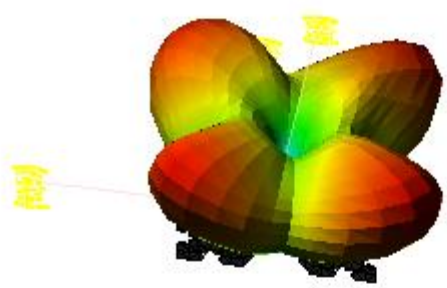


Fig: Proposed Koch Fractal Antenna with Capacitive Feed Fig: 3-D Radiation Pattern of antenna

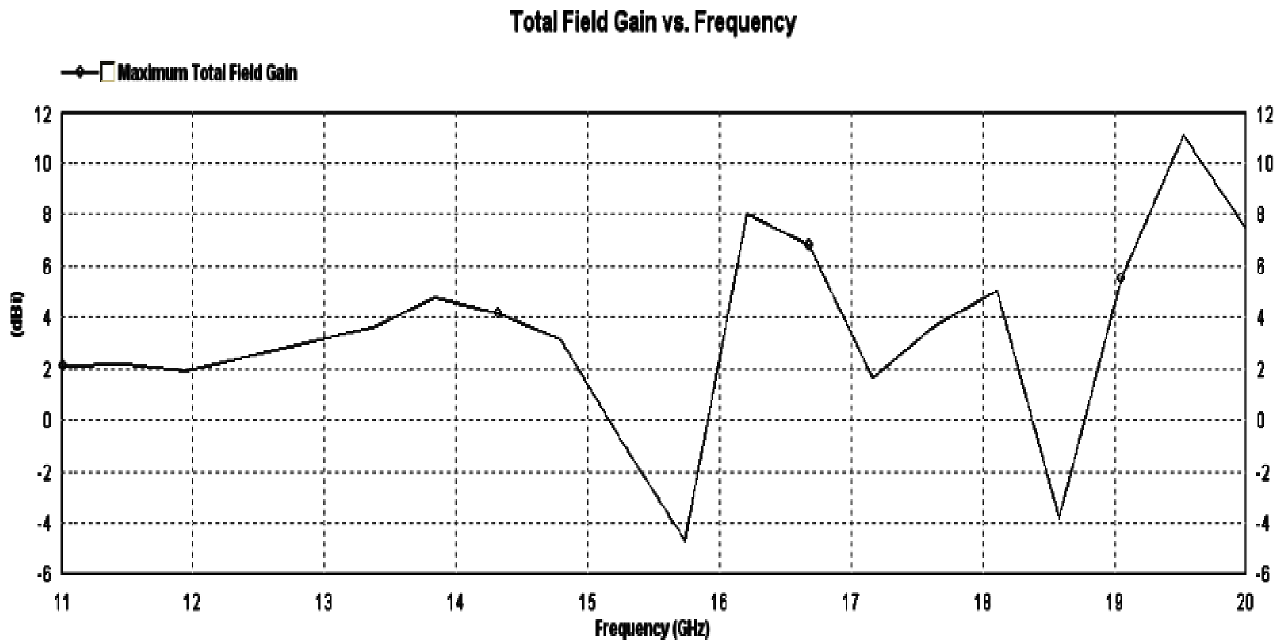


Figure. Proposed antenna’s Gain with respect to variation in frequency

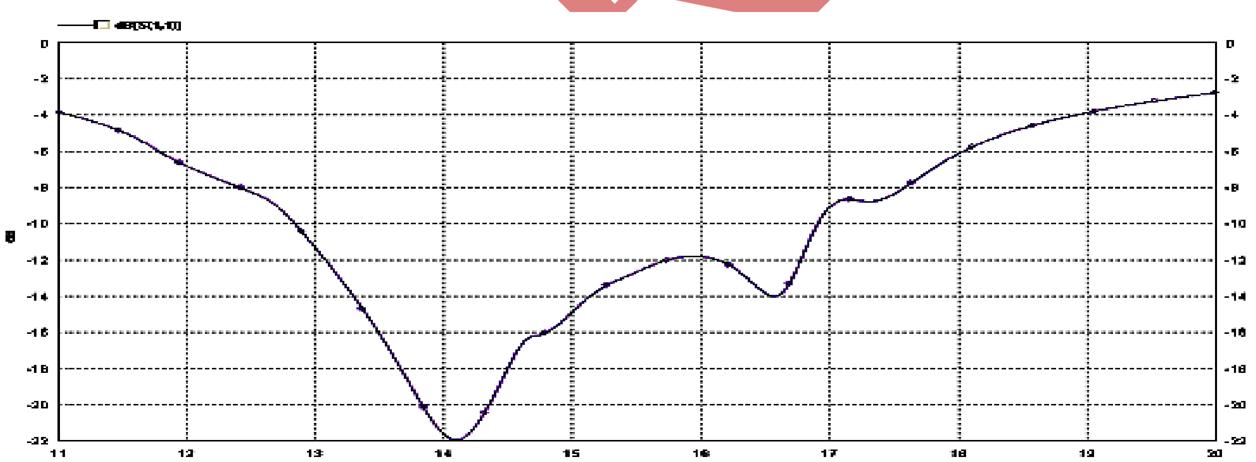


Figure. Proposed antenna’s Reflection Coefficient with respect to variation in frequency

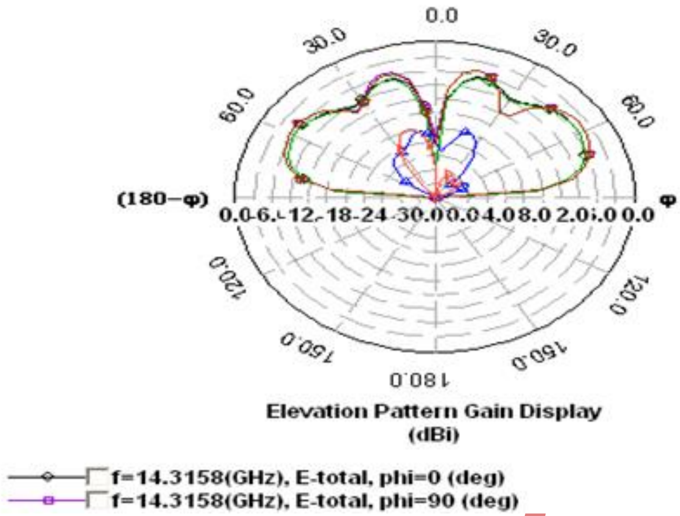


Figure. Proposed antenna's Elevation Pattern

V. CONCLUSIONS

A novel 12-17 GHz fractal planar microstrip antenna with excellent very wide band performance has been successfully demonstrated. This antenna has VSWR 2 : 1 or better linear polarization, SMA center fed, partial ground plane and no balun required. The impedance bandwidth of the antenna is 28%. The resonance behavior and space filling capabilities of the koch based square patch fractal antenna have been investigated. It is found that as the resonant frequencies and gain of loop is decreased as the generating iterations is increased. By introducing a ground patch of a specific dimension improves the antenna gain as well as its bandwidth. The antenna is compact, simple to design and easy to fabricate and applicable in wide band communication systems and commercial existing systems such as, UMTS and WLA . This antenna can also serve in UWB and wireless USB applications.

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