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Design of Coplanar Integrated Triband Microstrip Antenna with Koch Structure using CAD-FEKO

Miss.Vishnupriya A. Shinde[1], Prof. Sunil R. Gagare[2], Prof. Rekha P. Labade[3]

[1]*Department of Electronics and Telecommunication, Amrutvahini College of Engineering Sangamner, vishnupriya.shinde@gmail.com*
[2]*Department of Electronics and Telecommunication, Amrutvahini College of Engineering Sangamner, sunilgagare@yahoo.co.in*
[3]*Department of Electronics and Telecommunication, Amrutvahini College of Engineering Sangamner, rplabade@gmail.com*

Abstract— In this paper, A Triband Micro strip antenna is designed and simulated on CAD-FEKO electromagnetic simulation software. Modern telecommunication systems require antennas with smaller dimensions and wider bandwidth. The micro strip antenna with Koch structure is preferred due to light weight, small size and easy installation. Antenna properties such as return loss, directivity, VSWR and impedance are analyzed and discussed in this paper. Design and analysis of micro strip antenna is done by using software CAD-FEKO suit for continuous frequency band 1.2GHz-2.8GHz. With Koch structure, the designed antenna resonates at frequencies 1.6GHz, 1.775GHz and 2.32GHz for GPS, GSM and LTE2300 applications respectively. The optimized micro strip antenna has footprint of 50 mm x 70 mm with tangent loss of 0.002.

Keywords- Koch curve, triband, microstrip, CAD-FEKO suit, feed line.

I. INTRODUCTION

The increasing use of wireless communication systems demands the antennas for different systems and standards with antenna properties like moderate gain, broadband, multiband operations and reduced size [2]. In the field of wireless communications, an antenna plays an important role. Microstrip antenna is key building in wireless communication. Out of many antennas in communication system, microstrip antenna is very popular and well known for its advantages such as planer configuration, ease of fabrication, low profile, low volume, light weight and it has capability of dual and triple frequency operations. Because of these features this antenna attracts many researchers to investigate performance of antenna in various ways [1].

The major limitation of Microstrip antenna is their narrow bandwidth. Narrow bandwidth of microstrip patch antennas makes researchers think of dual and triband application antenna. Different types of microstrip antennas have been proposed for many applications with different shapes such as rectangular, circular disc, elliptical etc [7]. In this paper, we used rectangular structure. Microstrip antenna is designed on substrate such as FR4 with dielectric constant of 4.4 and thickness of 1.6mm. Performance of microstrip antenna is strongly depends on several factors such as feeding technique, thickness and dielectric constant of substrate [8]. Here, Koch structure is used to design triband microstrip antennafor given applications. The patch geometry and feed position are optimized by

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using Koch structure to increase the number of bands while keeping small antenna footprint. Here, Koch curve on the patch is investigated for reducing the size and enhancing the gain [6]. This paper is devoted to the simulation of this antenna in the frequency of 1.6 GHz for global positioning system (GPS), 1.75GHz for GSM and 2.32GHz for LTE2300 applications, to determine the parameters necessary for antenna's design. The microstrip antenna has very low volume and low profile and it can be fabricated using printed circuit techniques. This can be implies that the antenna can be made potentially at low cost and conformable [9].

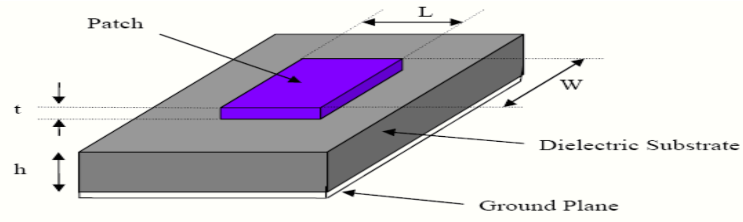

Figure 1. Structure microstrip patch antenna

A radiating patch, dielectric substrate and ground plane are the elements of microstrip patch antenna as shown in Figure 1. The conducting patch can take any possible shape and is generally fabricated using conducting material such as copper or gold. For better performance, dielectric substrate must have a low dielectric constant which is desirable. Since this provides better efficiency, larger bandwidth and larger radiation. However, such a configuration leads to a larger antenna size. In order to design a compact size Microstrip patch antenna, higher dielectric constants must be used which are less efficient and result in narrower bandwidth. Hence a compromise must be reached between antenna dimensions and antenna performance [3]. Feeding mechanism plays an important role in antenna design. This microstrip antenna reduces the production cost [4]. This paper is divided into following sections. The antenna geometry and iterative structure of Koch fractal curve is presented in the next section. The section 3 presents the performance of rectangular shaped microstrip patch antenna and simulation is done using CAD FEKO electromagnetic software also presented. Finally conclusion of antenna is given.

II. ANTENNA DESIGN

The basic geometry of triband microstrip antenna with Koch structure is shown in Fig. 2. The dimension of substrate is taken as 50 x 70 mm^2. The thickness (h) of substrate is taken as 1.6 mm. The microstrip patch antenna is used for mobile communications so it is necessary that antenna is not bulky. Hence, as per the application the height of the dielectric substrate is selected [13]. The coplanar geometry is being formed by mounting the radiating monopole antenna and rectangular patch antenna on same plane. This antenna is mounted on FR-4 printed circuit board (PCB) substrate with a dielectric constant of 4.4 and tangent loss of 0.002. Here microstrip feed line is used for monopole antenna for GPS applications and coaxial feed line is used for rectangular patch for GSM and LTE2300 applications. This antenna supports simultaneously for GPS at 1.6 GHz, GSM at 1.75 GHz and LTE2300 at 2.32 GHz frequency with linear polarization. The structure is designed because of requirements with different radiation and polarization so in order to improve the utility efficiency of limited spectra and special resources, different services using same antenna are required [10]. There are few software available which allow the optimization of the antenna. CADFEKO is one of the imperial electromagnetic software which allows to designing and solving for radio and

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microwave application. The CADFEKO simulator tool computes most of the useful parameters of interest such as radiation pattern, input impedance, return loss, VSWR, directivity etc [11].

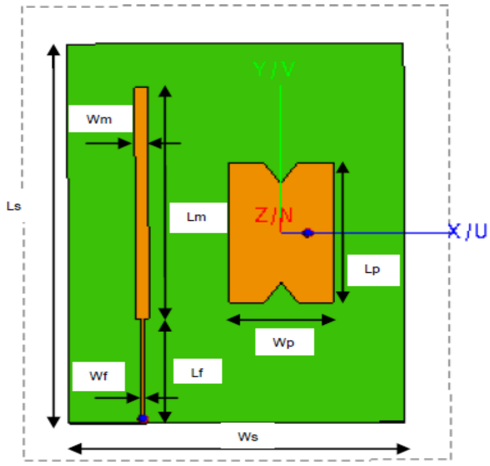

Figure 2. Design geometry of coplanar integrated microstrip antenna for GPS, GSM and LTE2300 applications

For developing new and innovative design for antennas many fractal geometries are available. This design mainly consists of Koch fractal geometry of antenna. A fractal design which maximize length, or increase the perimeter of material that can receive or transmit electromagnetic radiation within a given total surface area or volume. The improved feature of some antennas in terms of resonant frequency, radiation resistance and bandwidth is nothing but small fractal antenna [9]. Iterative construction is as shown in fig. 3.

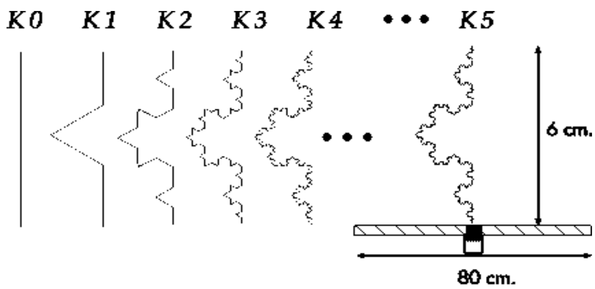

Figure 3. Iterative construction of Fractal Koch curve

The optimal dimensions of designed antenna are as follows: Ws = 50 mm, Ls = 70 mm, Wp = 27 mm, Lp = 44 mm, Wm = 4 mm, Lm = 96 mm, Wf = 1 mm, Lf =16 mm.

III. SIMULATED RESULTS

The coplanar triband microstrip antenna is simulated by electromagnetic simulation software CAD FEKO suit. By using fractal Koch structure high performance is achieved. The performance of antenna is shown in table 1.

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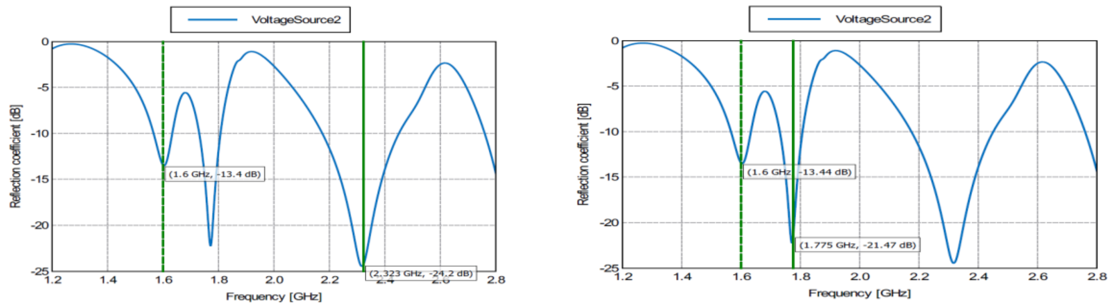
Table 1. Results of Simulation

Resonant Frequency (GHz)	Return loss (dB)	VSWR	Impedance(Kohm)
1.6	-13.44	1.54	0.073
1.775	-21.53	1.18	0.058
2.32	-24.25	1.13	0.072

3.1. Return loss

The return loss indicates how well the matching between transmitter and antenna has taken place. It is a parameter that indicates the amount of power i.e. lost to the load and does not return as a reflection. Fig 4 shows the simulated result of return loss for designed antenna. Ideal value of return loss is around -10dB which corresponds to VSWR of less than 2.

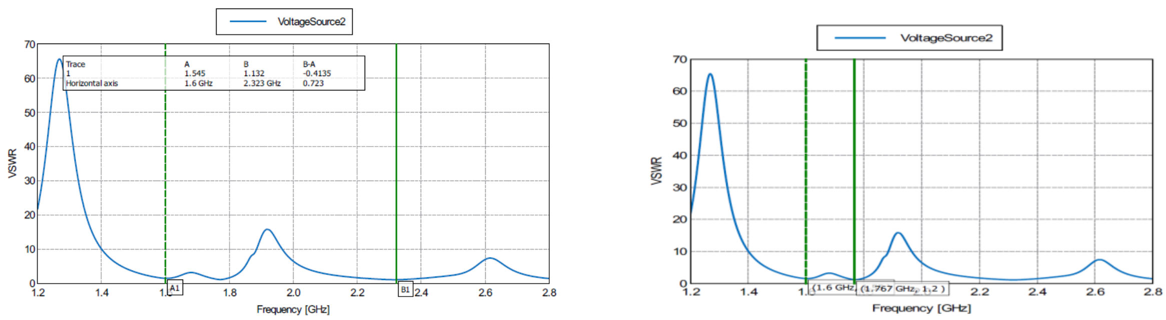


(a) *(b)*

Figure 4. Simulated result for Return Loss (a) at 1.6GHz and 2.32GHz (b) at 1.6GHz and 1.775GHz

3.2. Voltage Standing Wave Ratio (VSWR)

Voltage Standing Wave Ratio (VSWR) is ratio of maximum voltage and minimum voltage along transmission line. VSWR increases if there is mismatch between the antenna and transmission line and it is increases if there are good matching [12]. Fig.5 shows the simulated result of Voltage Standing Wave Ratio (VSWR) of simulated antenna.



(a) *(b)*

Fig 5. Simulated result for VSWR (a) at 1.6GHz and 2.32GHz (b) at 1.6GHz and 1.775GHz

3.3. Impedance

Input impedance is important to determine maximum power transfer between transmission line and antenna. This transfer only happen when input impedance of transmission line and input impedance of antenna matches [5]. Fig.6 shows the simulated results for antenna impedance.

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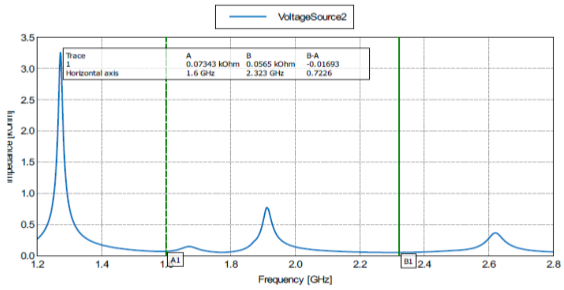
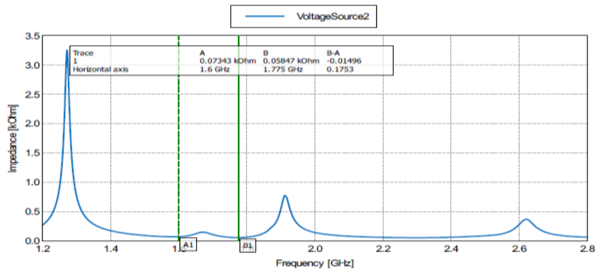
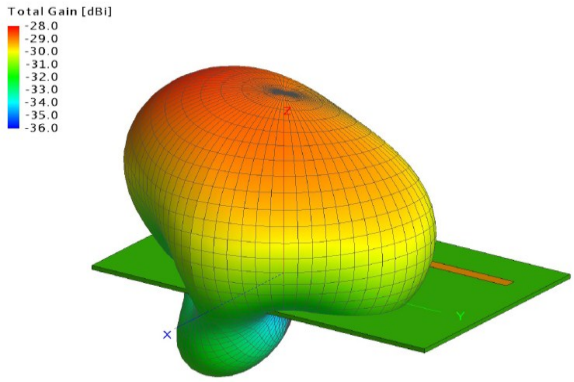




(a) ***(b)***

Figure 6. Simulated result for Impedance (a) at 1.6GHz and 2.32GHz (b) at 1.6GHz and 1.775GHz



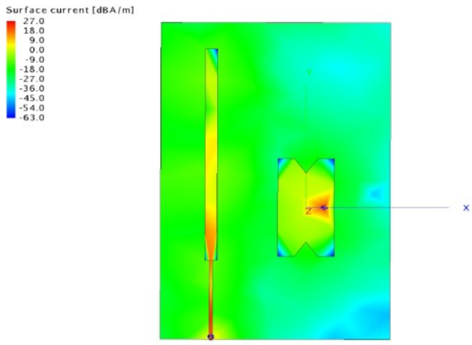


Figure 7. Simulated result for 3-D View

Figure 8. Simulated result for Current Distribution

CONCLUSION

The coplanar integrated microstrip antenna is designed and simulated. The design is simulated on CAD-FEKO suit which is electromagnetic simulation software. In this paper, the design and performance of triband antenna for triple frequency for GPS, GSM and LTE2300 systems are described. With Koch structure the size of antenna elements are reduced and high performance is achieved.

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