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Design and Optimization of Coplanar Integrated Microstrip Antenna with Koch Structure for GPS/Bluetooth Applications

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ABSTRACT

The coplanar implemented dual-band microstrip antenna is dually fed by co-axial probe and microstrip feedline with Koch structure is presented. The proposed antenna design consists of monopole antenna and rectangular patch antenna with Koch structure. The design is simulated by using CAD-FEKO suit (6.3), which is electromagnetic simulation software. The simulated and measured results show that the proposed antenna has an impedance bandwidth of Return loss around -10dB which corresponds to VSWR≤2 from 1.57GHz to 1.625GHz for GPS band and 2.33GHz to 2.5GHz for Bluetooth band.

Key words: Microstrip antenna, GPS, CAD-FEKO, feedline.

1. INTRODUCTION

The increasing use of microwave mobile communication systems demand the antennas for different standards and systems with properties like multiband operation, reduced size and ease of fabrication. Global Positioning System (1.57GHz) and Bluetooth (2.4GHz-2.484GHz) are the two important bands for wireless communication systems [1]. Here monopole antenna is resonating at 1.6GHz and rectangular patch antenna at 2.4GHz. Now day's single fed antennas are not practical. Hence, for antenna designers multifunctional antenna with different radiation characteristics has become more and more important [2]. The feeding method plays an important role in antenna design. Here monopole antenna is fed by microstrip line and rectangular antenna is fed by co-axial probe feed line. This dually fed antenna design resonate simultaneously. If we want to operate only one port at a time then we can disable other port which is not required, this is the advantage of this new design geometry.

Microstrip antennas become very popular because they are used for spaceborne applications, military and civilian applications. Microstrip antenna are low profile, conformable to planar and no planar surfaces, mechanically robust when mounted on rigid surfaces, simple and inexpensive to fabricate using modern printed-circuit technology, compatible with MMIC designs and very versatile in terms of resonant frequency, polarization and impedance[4]. As microstrip antenna has narrow bandwidth so researcher makes think of design of dual band antennas [3]. So in this paper, we present design of coplanar microstrip antenna with Koch structure to cover two bands. It is including design of antenna feed network, simulation and optimal antenna patch, selection of antenna's feeding methods and at last analyzing dielectric substrate, patch shape, height and other antenna parameters on the antenna performance[7].

2. PROPOSED ANTENNA DESIGN

2.1 Geometry of the Antenna

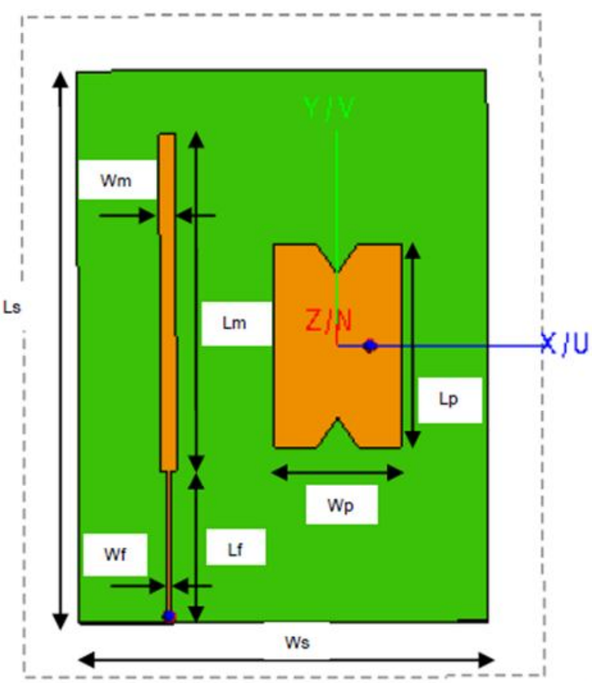


Figure 1: The geometry and parameters of proposed antenna

The geometry of proposed coplanar integrated dual-band antenna with Koch structure is illustrated in figure 1, with its geometry parameters. The proposed antenna is to be modeled using FR4 substrate with relative permittivity of 4.4, thickness of 1.6mm and tangent loss of 0.002. The dimension of this proposed antenna is 120 x 75 mm^2. In this paper, monopole antenna and rectangular patch antenna are placed on same plane. To avoid interference between these two antennas, this dual band antenna is designed with dual port functionality. With linear polarization, this antenna resonates at 1.6GHz for GPS and 2.4GHz for Bluetooth applications. The simulation of proposed antenna is being done using CAD-FEKO (6.3) software, which is based on MoM technique [5]. Dual band antenna with Koch structure is introduced here. With fractal Koch structure the size of antenna has been reduced. The fractal Koch technique has two important properties: self similarity and space filling property [6]. The design geometry is form by subtracting two triangles from original rectangular patch.

2.2 Parametric Study

The simulation tool CAD-FEKO (6.3) software is used for performing the design and optimization process. We have done the optimization process of coplanar integrated dual band microstrip antenna by slightly varying the dimensions of its different parameters near to their theoretically calculated values. The parameters selected for this process are feed position of patch and its length variation. The length of patch and feed position are selected in parametric study and study one parameter at a time and other is fixed to get better understanding for these parameters.

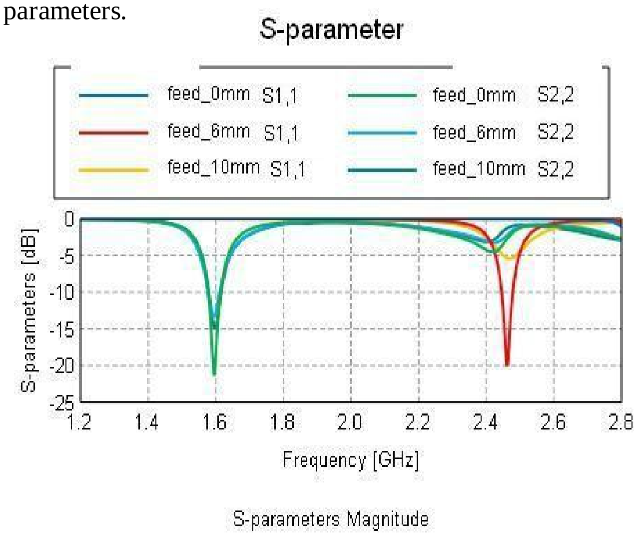


Figure 2: Simulated Return loss characteristics of Proposed Antenna with different value of feed points

Figure 2 shows effect of feed positions on return loss of this antenna design. For feed=6mm, antenna shows good matching over remaining feed positions compared to feed=0mm and feed=10mm. It can be seen that for feed=6mm, maximum negative value of return loss for dual frequency operation is obtained.

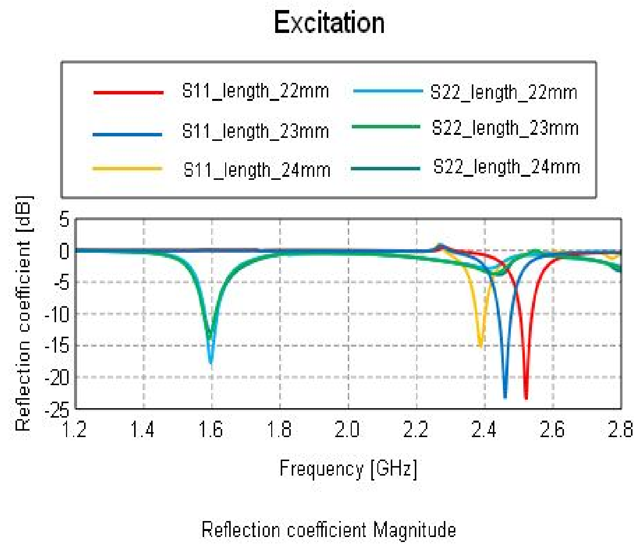


Figure 3: Simulated Return loss characteristics of Proposed Antenna with different value of patch lengths

Figure 3 shows the simulated return loss characteristics of antenna as the function of frequency for different values of patch lengths with other parameters are fixed. It can be seen that the value of patch lengths is not affected to first band. To get desired 2.4 GHz Bluetooth band the length of patch is adjusted. As the length of patch increases, we get the maximum negative value of return loss and better performance is achieved. For Lp= 23mm, we are getting maximum negative value of return loss at center frequency 2.4GHz.

3. RESULTS AND DISCUSSIONS

After the parametric study of several adjustments on parameters, the final proposed antenna is achieved. The design parameters of proposed antenna are given in table 1.

Table 1: Proposed Antenna Parameters

Parameters	Dimensions
Length of Substrate (Ls)	75mm
Width of Substrate (Ws)	120mm
Length of Patch (Lp)	28mm
Width of Patch (Wp)	38mm
Length of Monopole(Lm)	93mm
Width of Monopole (Wm)	3mm
Feed Length (Lf)	24mm
Feed Width (Wf)	2.8mm
Height	1.6mm
Dielectric Constant	4.4

Figure 4: Photograph of Proposed Antenna

In order to evaluate the performance of the optimized proposed antenna, the prototype of the proposed antenna was implemented and fabricated. The photograph of fabricated antenna is shown in figure 4. The return loss was measured by Aligent- N9916A vector network analyzer.

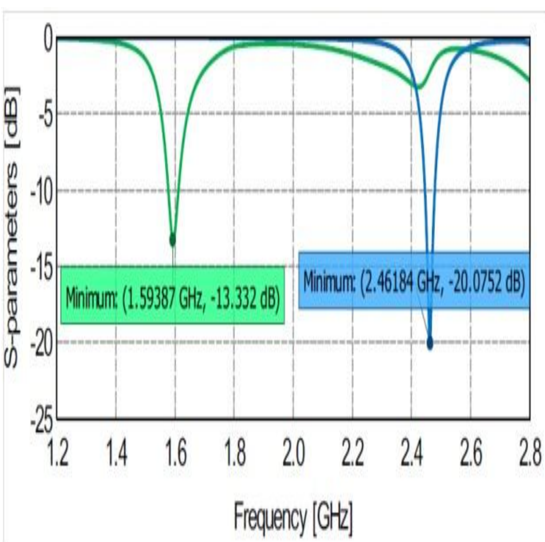


Figure 5: Return loss vs. Frequency (Simulated)

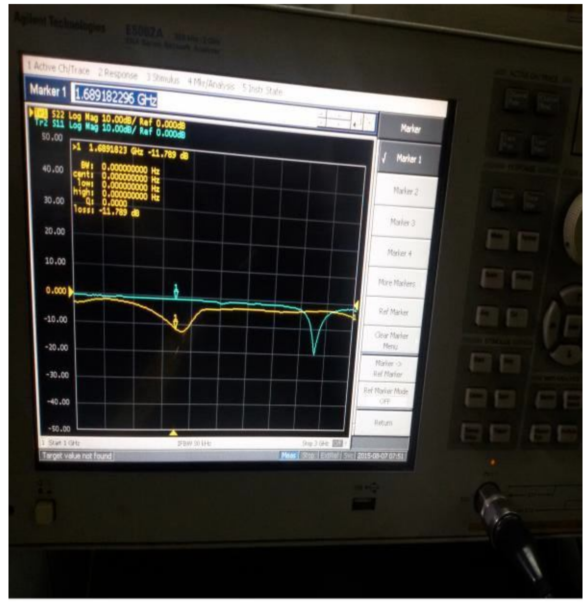
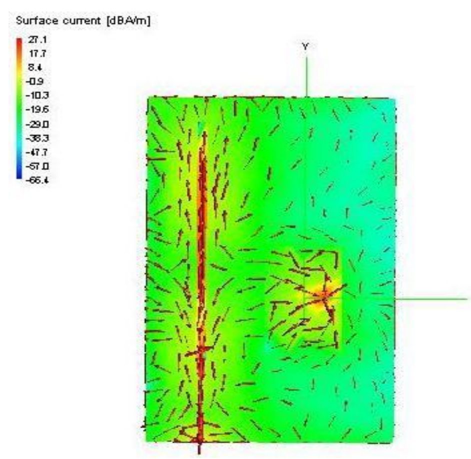
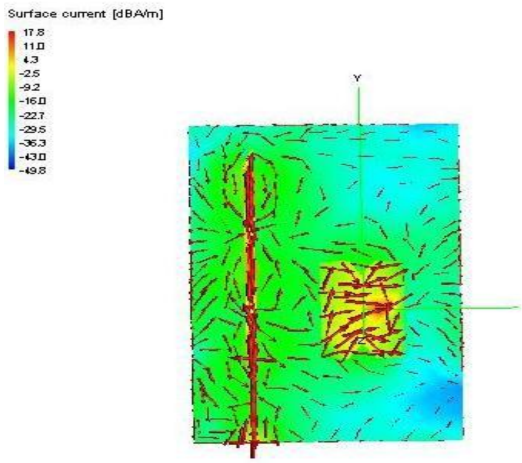


Figure 6: Return loss vs. Frequency (Measured)

The simulated and measured return loss of dual band microstrip antenna is shown in figure 5 and figure 6 respectively. Measured results are in good agreement with simulated results. The simulated return loss values of GPS and Bluetooth bands are -13.332dB at 1.59GHz and -20.0757dB at 2.46GHz and measured return loss values are -11.93dB at 1.6GHz and -20dB at 2.45GHz. Small variation in measured return loss are observed which may be due to fabrication accuracy, tolerance in manufacturing and soldering effects in SMA connector which is not taken into account in simulation results.



(a)



(b)

Figure 7: Surface current distribution at (a) 1.6 GHz (b) 2.4 GHz

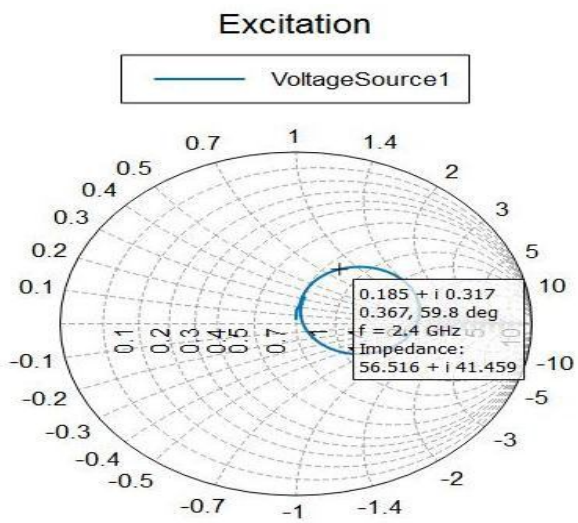


Figure 8: Input Impedance vs. Frequency (Simulated)

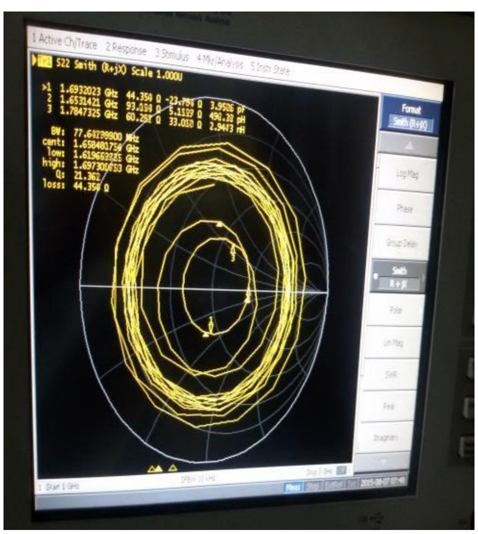


Figure 9: Input Impedance vs. Frequency (Measured)

Surface current distributions of proposed antenna at 1.6GHz and 2.4GHz are studied for better understanding of proposed antenna and are illustrated in Figure 7. The current distribution is highest along monopole and patch antenna for dual frequency operation. When input impedance of transmission line and input impedance of antenna matches then maximum power transfer between transmission line and antenna. [8]. Figure 8 shows at resonant frequency 2.4GHz the impedance matches to 56.51 ohm which is actually the good. Figure 9 shows the 44.35 ohm measured impedance at resonant frequency 2.4GHz which is in good agreement with simulated result.

5. CONCLUSION

In this paper, the design, simulation and measurement of dual band microstrip antenna with Koch structure has been presented. Antenna gives more negative value of Return Loss for dual frequency operation, hence BW is increased. So with Koch structure antenna performance is improved. We can continue this work by increasing number of iterations for increasing the number of operating frequency bands so that same design work for number of applications.

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