



Micro strip feed monopole circle to circle fractal antenna for multiband applications

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Abstract

In this paper, introduced monopole circle to circle fractal based antenna for multiband applications fed by microstrip line. The FR-4 substrate and copper material used in this proposed design. This is operated in between the 6-20GHz frequency band and achieves 8 resonant frequencies and also used for C/X/Ku/K band applications i.e., multiband applications. The Computer simulation technology software is used for design and discussed the general results of antenna-like reflection coefficient, VSWR, Gain, Radiation Pattern and efficiencies and dimensions of a proposed structure is 26mm x30mm x1.6mm.

Keywords: CST Software; Fractal Antenna; Micro Strip; Multiband Applications.

1. Introduction

In wireless communication, antenna plays a very important role and transducer among transmitter and free space and well controlled to radiate electromagnetic energy into free space [1]. In recent days, the system require small size, less weight, small profile and less size antennas for wireless communication and also need to provide more efficient, mobility and reliability [2-3].

Starting days micro strip patch antennas used due to simple to construct and consist of a patch that is placed a top of substrate, ground is used in bottom of the substrate and this antenna having low weight and size, used for mobile and aerospace applications [4-9]. The micro strip antennas have developed drastically for the period of the past 35 years, overcome the so many restrictions. The shape of the patch is generally circular and rectangular and changed the shapes day to day based on the user requirements. The monopole antenna is the first and regularly used antenna for microwaves frequency range to achieve the multiple resonant as well as multiband applications.

In 1970, French mathematician B.B. Mandelbrot coin the term "fractal". It comes from the common word fractus which is akin to the verb frangere. Most geometries have infinitely sub-distinct, with each sub divided copy of the parent.

Microstrip

The schematic representation of microstrip as shown in fig 1. The W and h are represented as a width of a strip and height of the substrate [10]. The design values are depending on the ratio of W, h and their notation are represented in equation 1 to 3.

In this paper, introduces micro-strip feed circle to circle fractal shaped antenna for multiband applications and designed as follows. Firstly, describe analysis and design of an antenna design in sec.2 follow by a conversation of the simulation result's in sec.3 and before I finish, the conclusion can be a term in Sec.4.

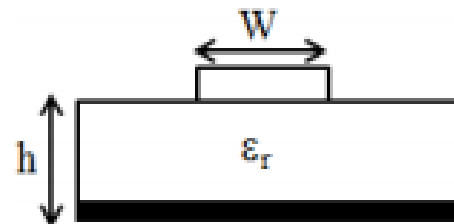


Fig. 1: Microstrip.

$$\frac{W}{h} = \begin{cases} \frac{2}{\pi} \left\{ \frac{\epsilon_r - 1}{2\epsilon_r} \left[\ln(a - 1 + 0.39) - \frac{0.11}{\epsilon_r} \right] \right\} & \frac{W}{h} > 2 \\ \frac{8\epsilon^a}{\epsilon^a - 2} & \frac{W}{h} < 2 \end{cases} \quad (1)$$

$$a = \frac{377\pi}{2Z_0\sqrt{\epsilon_r}} \quad (2)$$

Where

$$b = \frac{Z_0}{60\sqrt{\epsilon_r}} \sqrt{\frac{\epsilon_r + 1}{2}} + \frac{\epsilon_r - 1}{\epsilon_r + 1} \left(0.23 + \frac{0.11}{\epsilon_r} \right) \quad (3)$$

2. Proposed design

The proposed structures as represented in fig 2 and it has three different iteration models of an antenna, indicated as @1, @2 and @3. All the design are used as an FR-4 substrate with a dielectric constant of 4.4 with a height of 1.6mm. the copper material used as the ground of this design with a thickness of 0.035mm, the feed is used for design is microstrip.

The antenna1(@1) contains the first iteration of the circle to circle with an thickness of r1 and an inner circle radius is R, that is also called as monopole ring shape. The center of the first circle is divided into three parts with an angle of 120 degrees and

introduces three circles with three different centers that are C_1, C_2, C_3 and their inner radius is R_1 with a thickness of r_2 , this is represented in antenna2(@2). The same thing is repeated for another iteration called as third iteration and represented in antenna3 (@3). The Fig. 3 describes the parametric representation of a proposed design and parameters used for design as shown in table 1. The centers used for introducing monopole circle to circle mentioned in this are represented in co-ordinate system and mentioned in table 2.

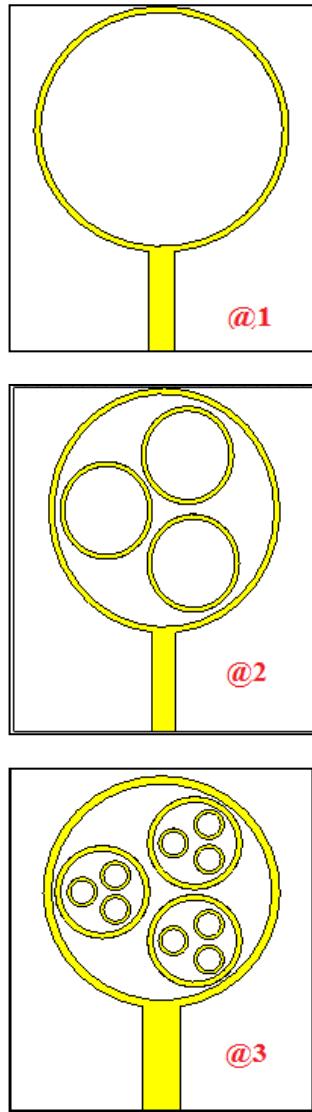


Fig. 2: Proposed Structure.

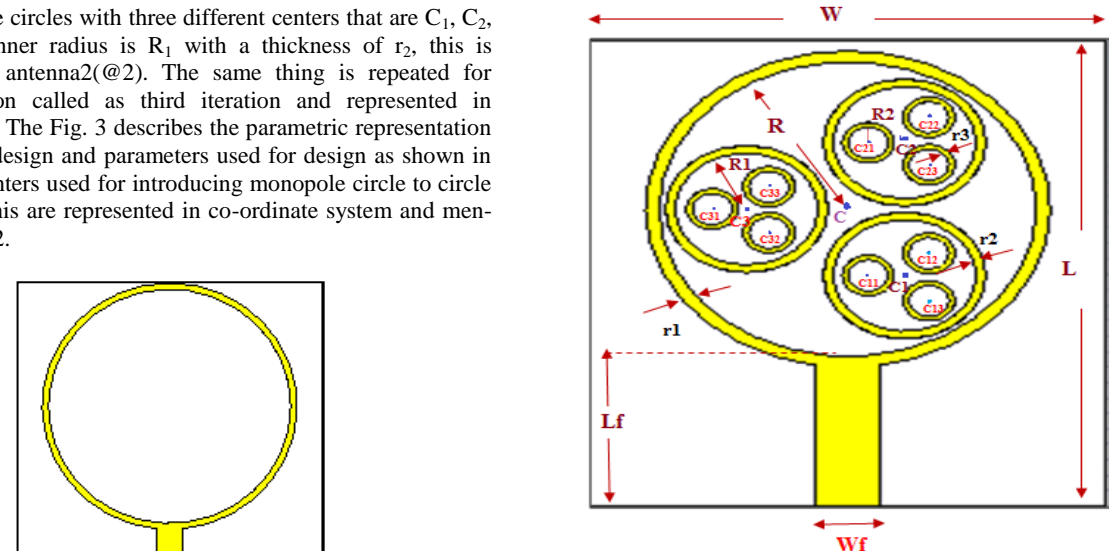


Fig. 3: Parametric Representation of Proposed Design.

3. Result and discussion

The reflection coefficient for three iteration models as shown in fig.4. The first iteration model (@1) as produces three resonant frequencies that are 8GHz, 10GHz, 12GHz. the second iteration (@2) model as provides three resonant frequencies that are 8.2GHz, 10GHz, 12GHz. the final iteration provides eight resonant frequencies and discussed clearly in fig. 5.

The reflection coefficient over a frequency as represented in fig. 5 and observed the result in the range of 6 to 20GHz, produces eight resonant frequencies and also used for C-band/ X-band/ Ku-band/ K-band applications. The resonant frequencies are 7.327GHz, 7.992GHz, 9.58GHz, 11.354GHz, 13.351GHz, 15.601GHz, 17.435GHz, 18.713 and those resonant frequency reflection coefficient values are -14.72dB, -18.534dB, -13.255dB, -21.376dB, -16.679dB, -14.305dB, -33.043dB, -12.251dB.

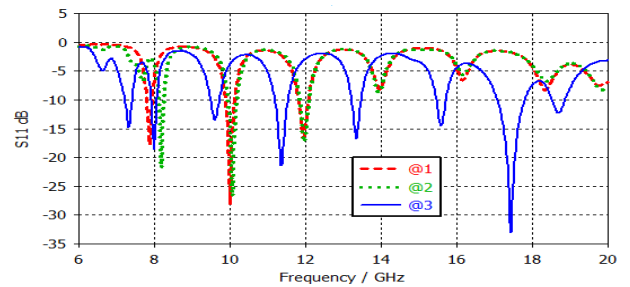


Fig. 4: Reflection Coefficient for All Iterative Models.

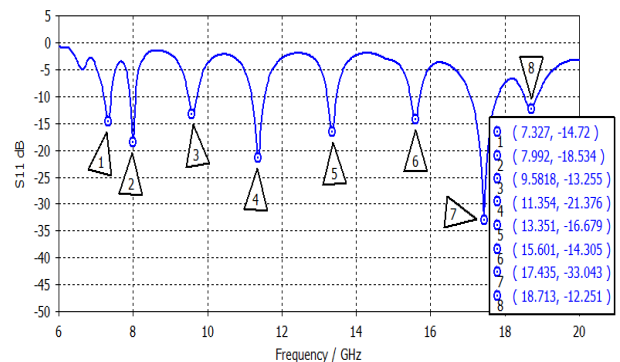


Fig. 5: Reflection Coefficient over A Frequency.

Table 1: Parameters Used for Design

Parameter	Dimension	Parameter	Dimension
W_f	3.2	r_2	0.5
W	26	r_3	0.3
L	30	R	9.5
L_f	8.5	R_1	4
r_1	0.7	R_2	1.2

Table 2: Circle Positions

Name	Position	Name	Position
C	(13, 18)	C_{21}	(14, 22.2)
C_1	(8,18)	C_{22}	(17, 23.8)
C_2	(15.8, 22.2)	C_{23}	(17, 20.4)
C_3	(15.8, 13.8)	C_{31}	(14, 13.8)
C_{11}	(6, 18)	C_{32}	(17, 15.2)
C_{12}	(9.2, 19.4)	C_{33}	(17, 12.4)
C_{13}	(9.2, 16.4)		

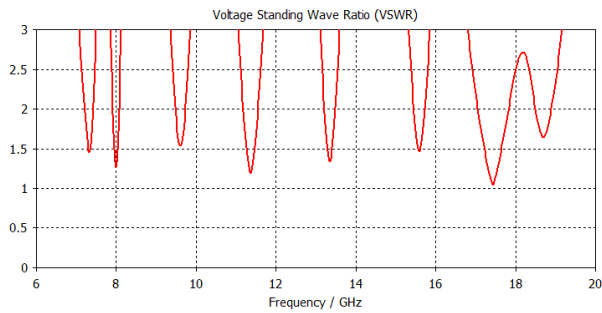


Fig. 6: VSWR for A Proposed Design.

The bandwidth occupied for the proposed design is 188MHz at 7.327GHz, 150.5MHz at 7.992GHz, 227MHz at 9.5818GHz, 361MHz at 11.354GHz, 258MHz at 13.351GHz, 300MHz at 15.6GHz, 720MHz at 17.435GHz and 339MHz at 18.713GHz. The VSWR of a proposed design as represented in fig.6 and operated over a frequency 6 to 20GHz. The VSWR values at each and every resonant frequency are 1.46, 1.25, 1.55, 1.2, 1.35, 1.5, 1.005 and 1.65. The impedance bandwidth of this design match with VSWR bandwidth with a reference line of VSWR=2.

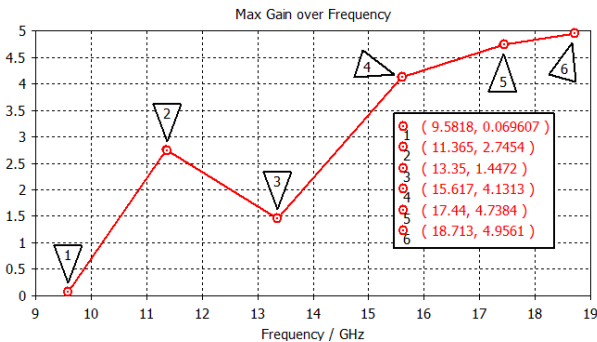


Fig. 7: Frequency vs Gain.

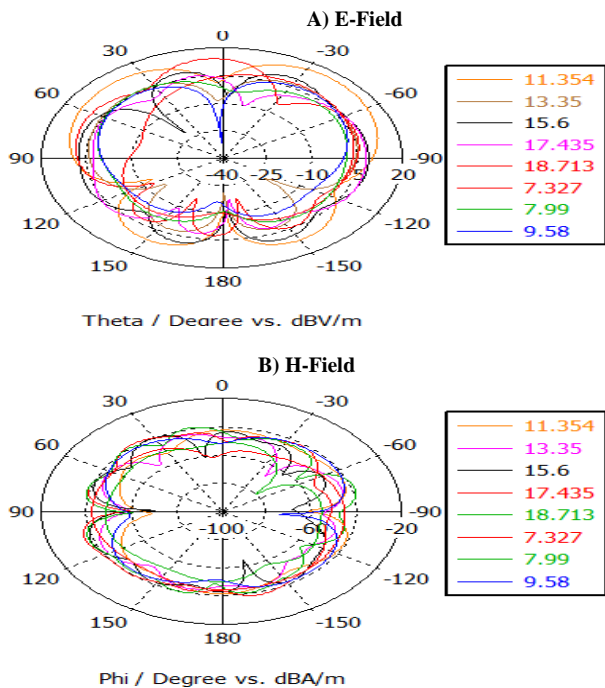


Fig. 8: Radiation Pattern.

The frequency versus gain for a proposed antenna as shown in fig 7. The gain values are 0.069dBi at 9.58GHz, 2.74dBi at 11.365GHz, 1.4472dBi at 13.35GHz, 4.13dBi at 15.617GHz, 4.73dBi at 17.44GHz and 4.95dBi at 18.713GHz. The two-dimensional radiation pattern of a proposed antenna as represented in fig. 8 and fig 8a, fig 8b represents the E-field and H-field of an antenna for all resonant frequencies. The fig 9 represents the surface current of a proposed design and red color in the structure

shows highest current flow and also the current flow is changed based on the frequency, clearly observed from fig 9.

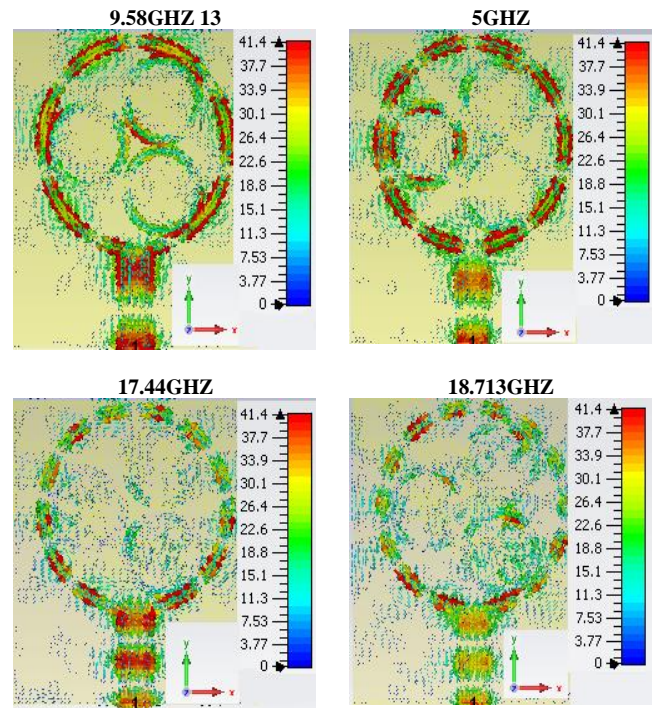


Fig. 9: Surface Current.

4. Conclusion

The design and analysis of circle to circle monopole fractal antenna was introduced in this paper for multiband applications. This produces eight resonant frequencies those are 7.327 GHz, 7.992GHz, 9.588GHz, 11.345GHz, 13.35GHz, 15.573GHz, 17.435GHz, 18.749GHz and their reflection coefficient values are -14.72dB, -18.534dB, -13.493dB, -24.436dB, -16.709dB, -14.35dB, -17.435dB, -11.9dB.

References

- [1] Bashar B. Qas Elias (2016) "Design of Broadband Circular Patch Microstrip Antenna for KU-Band Satellite Communication Applications", International Journal of Microwave and optical Technology, Vol. 11, No. 5, pp. 362–368.
- [2] B. J. Kwaha, O. N Nyang and P. Amalu (2011) "The Circular Microstrip Patch Antenna – Design and Implementation" IJRSS, Vol. 8, No. 8, pp 88–95.
- [3] Sarthak Singhal and Amit Kumar Singh (2016) "Modified Star-Star Fractal Super-Wideband Antenna" MOTL, Vol. 59, No. 3.
- [4] Naveen Jaglan, Binod K. Kanaujia, Samir D. Gupta, and Shweta Srivastava (2016) "Triple Band Notched UWB Antenna Design Using Electromagnetic Band Gap Structures" Progress In Electromagnetics Research C, vol. 66, pp. 139–147.
- [5] M. Dinesh, M. Nandakumar and A. Balachandreddy (2018) "Micro-strip Feed Reconfigurable Antenna for Wideband Applications" Journal: Lecturer notes in electrical engineering" pp: 665-671.
- [6] Y. Tawk, Alex R. Albrecht, S. Hemmady, Gunny Balakrishnan, and Christos G.Christodoulou (2010) "Optically Pumped Frequency Reconfigurable Antenna Design" IEEE Antennas and Wireless Propagation Letters, Vol. 9.
- [7] Rahul Tyagi, SaurabhKohli (2015) "Design and Development of Square Fractal Antenna for Wireless Application", International Journal of Advanced Research in Computer Science and Software Engineering, 2.
- [8] J. Malik and M. V. Kartikeyan (2012) "Metamaterial Inspired Patch Antenna With L-Shape Slot Loaded Ground Plane For Dual Band (Wimax/Wlan) Applications", Progress In Electromagnetics Research Letters, Vol. 31, pp. 35–43.
- [9] Li-Ming Si, Weiren Zhu, and Hou-Jun Sun (2013) "A Li-Ming Si, Weiren Zhu, and Hou-Jun Sun, "A Compact, Planar, and CPW-Fed

Metamaterial-Inspired Dual-Band Antenna,” IEEE Antennas and Wireless Propagation Letters, 12.

- [10] Nanda Kumar M, T Shanmugnantham (2018) “Design of Substrate Integrated Waveguide back to back π -shaped Slot Antenna for 60GHz Applications” Journal: Lecturer Notes in Electrical Engineering, pp. 215-224.