Circular Ring Loaded Flower Shaped Antenna for Triple Band Applications

S. S. Mohan Reddy, A. Manjusha, K. Aruna Kumari, B.T.P Madhav, B. Prudhvi

Abstract*: This article presents the design and analysis of triple band micro stripantenna for various wireless communication applications. The deigned antenna consists of circular ring loaded flower shaped antenna having a circular slot in the centre of the patch. The center slot in the middle of the patch is responsible for improving the reflection coefficient of the antenna. The antenna shows triple band characteristics with resonating frequencies at2.52 GHz /4.58 GHz /7.2 GHz with bandwidth of 0.25GHz, 0.57GHz and 0.71GHz respectively. The antenna provides a maximum peak gain of 3.8dBi at 2.52 GHz and provides Omni-directional and bidirectional patterns. The proposed antenna is designed on FR4 substrate having dimensions 41.8 x 28 x 1.6 mm^3 and having a loss tangent of 0.02.

Index Terms*: Ultra-wideband (UWB), Triple band, Flower shaped antenna.

I. INTRODUCTION

The rapid development for wireless technology has demanded for multiple frequency antennas which can cover many frequency applications. The designed antennas must cover the wireless applications like WLAN and WiMAX which operates in frequency range of 2GHz and 6GHz [1]. To obtain these standards, the designed antenna should have excellent characteristics like high bandwidth, size, and gain and so that it can be easily integrated to other wireless systems. To adapt to the diverse and complicated environments several dual band and multi band antennas are presented in this literature. A simple triple band is designed with microstrip slot antenna for WLAN/WiMAX applications [2]. The circular arc shaped antenna is designed by the Zhai [3] with compact structure for WLAN/WiMAX applications. One of the important parameters of this antenna is circular arc that can be properly tuned to obtain the triple band characteristics. The dual, triple band antennas with asymmetric dipole antenna is designed for WLAN and Laptop computer applications with C-shaped parasitic strip to tune the obtained resonating frequencies [4]. The triple band antenna is designed with two triangular rings which are arranged in the opposite direction to obtain the triple band and triple polarization [5]. The compact rectangular ring loaded with fork shaped antenna is designed for WiMAX/WLAN applications [6]. The circularly polarized slot antenna for triple wide band operations is designed to cover various WLAN and WiMAX application frequencies [7]

In this letter a simple triple band antenna is designed. It consists of circular ring with four petals separated with an angle of 90^0 to each other. In the ground structure defected ground (or half ground) structure is taken to enhance the performance of the antenna. This antenna is inspired from the flower Cardamine Californica with compact in structure.

II. ANTENNA DESIGN

The designed antenna geometry is presented in Fig.1 which shows the iterations of basic antenna model of the proposed antenna. The antenna designed with FR4 substrate having thickness 1.6mm. The flower shaped radiator is printed on upper surface of the substrate and used to generate the triple band resonance condition. In the lower frame of the substrate the partial half ground structure is taken with the dimensions 41.8 x 28mm.

Table1 : Antenna Dimensions

Parameter	Value (mm)	Variable	Value (mm)
Ws	28	R1	12
Ls	41.8	R2	10.5
Lg	16	Lf	1.5
Wg	28	Wf	16
H	1.6	O	2

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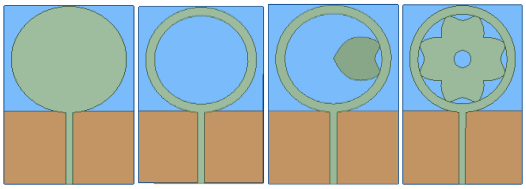
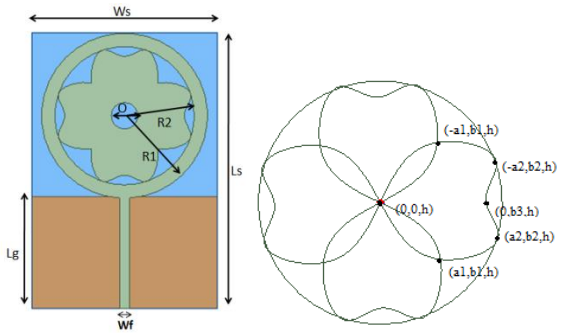


(a) (b) (c) (d)

Fig 1: Iteration of the proposed antenna model
(a) iteration 1 (b) iteration 2 (c) iteration 3
(4) Proposed antenna.

In Fig.2 size of each petal and detailed dimensions are presented. The basic circular antenna is considered and modified to circular ring in the second iteration of the antenna.



(a) (b)

Fig 2 : Dimensions (a) Proposed antenna (b)Structure of the Petals

In the circular ring, the antenna is loaded with petal shaped structure and arranged at an angle of 90^0 apart with circular slot at the middle of the antenna. The dimensions of the antenna are presented in the Table.1

III. RESULTS AND DICUSSIONS

Fig 3 represents the reflection coefficient of the itertions of the proposed antenna models. The basic iteration of the antenna operates in the frequency range of 6.33 GHz -7.27 GHzwith bandwidth of the 0.9 GHz. The second iteration of the antenna consists of the circular ring structure and shows reflection coefficient of the 6.1 GHz – 6.8 GHz with bandwidth of 0.7 GHz. In the third iteration the antenna resonates in the frequency ranging from the 4.7-6.8 GHz which cover many WiMAX application frequencies.

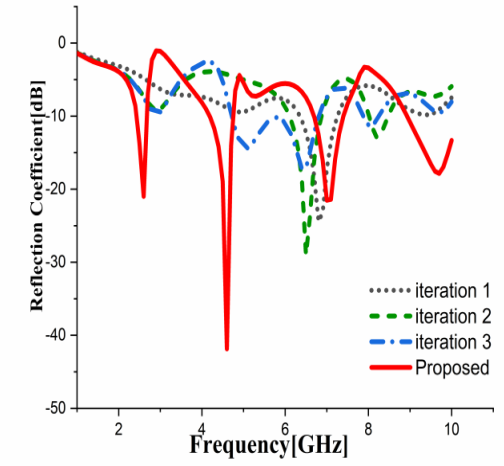


Fig 3: Reflection coefficient of iterations and proposed model

The proposed antenna shows the triple bnad charcteristics operating from 2.4-2.62 GHz with bandwidth of 0.22 GHz and at the second resonating frequeny band of 4.18 GHz-4.78 GHz with bandwidth of 0.55 GHz is observed. Similarly at the third resonating band the antenna operates in the range of 6.7-7.3 GHz with bandwidth of 0.6 GHz. The antenna provides the minimum S_{11} of -21 dB, -41 dB and -29 dB. This antenna covers the various application like WLAN,ISM, INSAT and X-band applications.

A. Parametric Study:

To obtain the optimised parameters of the antenna each parameter of the antenna is gone through the parametric analysis. The parametric analysis carried out by varying the length of the ground structure, width of the feed, radius of the second circle and the radius of the slotted circle.The length of the ground is varied with Lg= 15mm-18mm. Other geometrical parameters are kept constant while considering the effect of certain geometrical paameter. The reflection coefficient is observed in Fig.4. It shows variation of reflection coefficient of antenna when ground is subjected to parametrics.

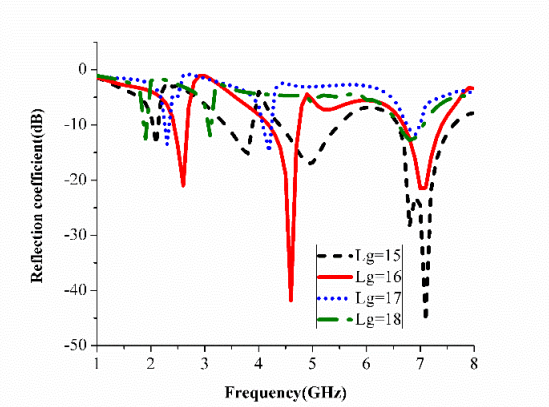


Fig 4**:** Parametric analysis for varying the ground length.

The required output is observed to be triple band when length of the ground is 17mm.The width of the feedline is varied Wf= 1mm-2.5mm with step size of 0.5mm. The results can be observed in Fig.5. It shows variation of reflection coefficient of antenna when feedline is subjected to parametrics. It can be seen that shift in resonant frequency occurs in third band and First and second bands are slightly affected. The required output is observed to be triple band when width of feedline is 2mm.

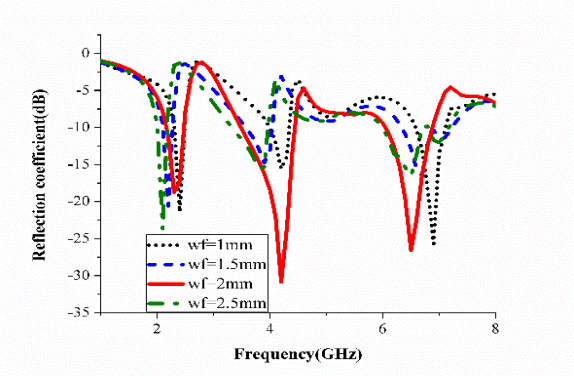


Fig 5: Parametric analysis for varying feed width.

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The radius of the second circle is varied R2= 9.5mm-11mm. The reflection coefficient can be observed in Fig 6. It shows variation of reflection coefficient of antenna when second circle is subjected to parametrics. Second band is affected when radius is altered. The required output is observed to be triple band when radius of second circle is 10.5mm.

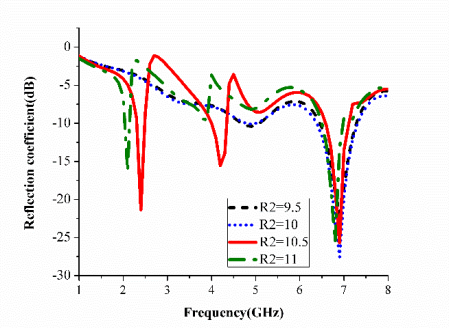


Fig 6: parametric analysis for varying radius of the circle R2

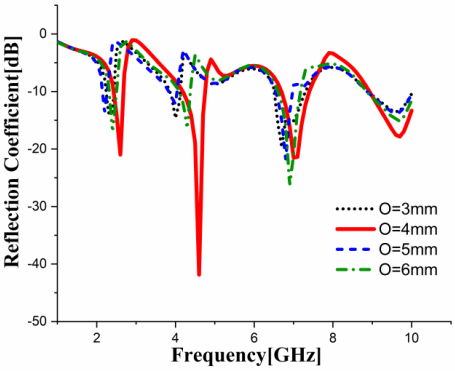
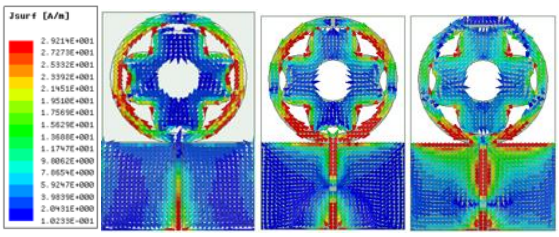


Fig 7. parametric analysis for varying slotted ciecle radius O=3-6 mm.

The radius of the circular slot is varied O= 3mm-6mm with step size of 1 mm. The reflection coefficent can be observed in Fig 7. It shows variation of reflection coefficient of antenna when circular slot is subjected to parametrics. The required output is observed to be triple band when radius of circular slot is 4mm.

B. Surface Current Distribution

Fig.8 shows the simulated surface current distributions on the proposed microstrip line-feed flowershaped antenna at the frequenies of 2.52, 4.58, 7.2GHz. Surface curent is high in the circular ring than in the flower. It indicates that antenna radiations are from the edge of the patch. At 2.52Ghz current distribution is in the circular patch. As frequency increases to 4.58GHz current enters into flower and flows in the perimeter of the patch. The feedline has a minima at input end of the patch. With increase in frequency to 10GHz maximum current is in the feedline which is passed to the circular ring and then to the flower.

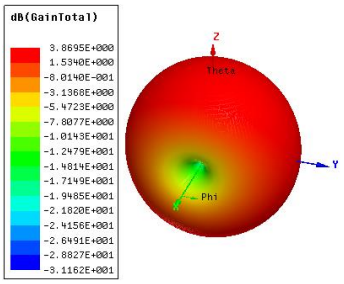


(a) (b) (c)

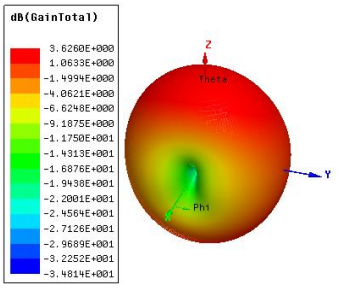
Fig 8: Surface Current Distributions on the proposed Line-Feed flower shaped at (a)2.52(b)4.58(c)7.2GHz.

C. GAIN

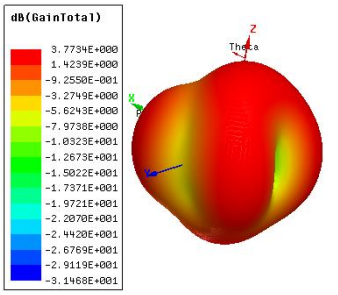
Fig.9 shows the polar gain of proposed Microstrip patch antenna with line feeding. The antenna operates at 3 resonating frequencies 2.52GHz, 4.58GHz, 7.2GHz. The gain observed at 2.52GHz is 3.86dB, 4.58GHz is 3.62dB and 7.2GHz is 3.77dB.



(a)



(b)



(c)

Fig 9: Gain pot for resonating antenna at (a)2.52 GHz (b)4.58 GHz (c)7.2 GHz

D. RADIATION PATTERN

The radiation patterns of proposed antenna both in E-plane and H-plane are obtained using Anyss HFSS software. Figure 10 shows the Far-Filed radiaton patterns of the proposed antenna. Omni directional radiation pattern is observed in E-plane and Bi directional pattern is observed in H-plane. These patterns are observed at resonating frequencies such as 2.52 GHz, 4.58 GHz, 7.2 GHz.

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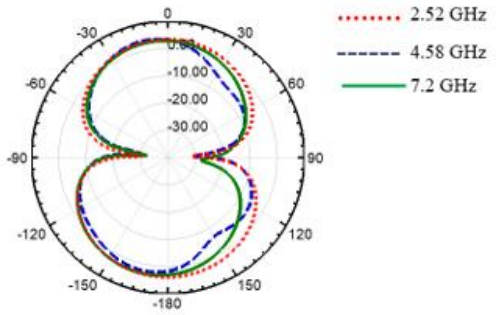
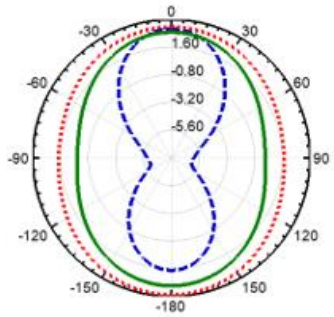


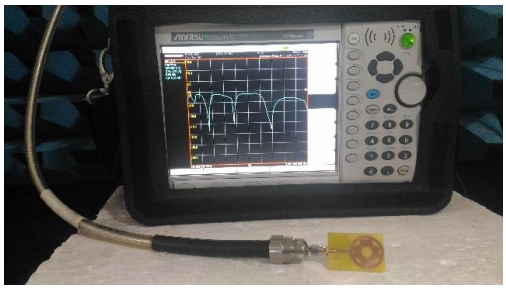
(a)



(b)

Fig 10: Radiation patterns at both (a) E-plane (xz-plane) (b) H-plane(yz-plane).

E. MEASURMENT SETUP



(a)

(b) (c)

Fig 11: Measurement setup (a) Tested using network analyzer. Fabricated antenna(a)Top view (c) Rare view

The Fig11 represent the measurement setup for testing the antenna and prototype of the antenna designed using Nivs 72 protype machine and tested using the Anritsu combinational analyzer.

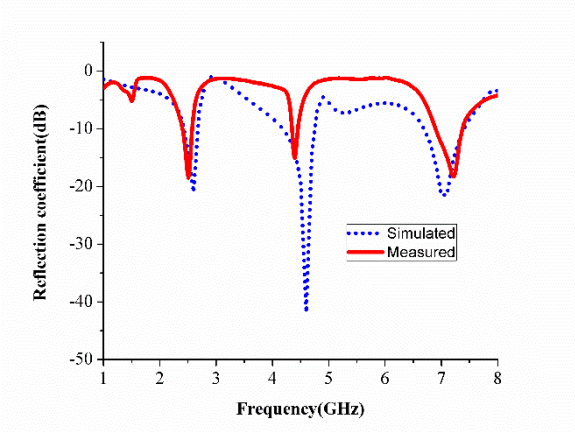


Fig 12.Simulated and measured results

Table 2: Comparison of measured and simulated results.

S.No	Parameter	Simulated	Measured
1	Frequency range (GHz)	2.4-2.62	2.41-2.56
		4.18-4.78	4.25-4.52
		6.7-7.3	6.8-7.35
2	Bandwidth (GHz)	0.22	0.15
		0.55	0.27
		0.6	0.55
3	S_{11}(dB)	-21	-17
		-41	-16
		-29	-18
4	Impedance band width (%)	8	6
		12	6.9
		8	7

IV CONCLUSION

The article presents the triple band antenna forWLAN(2.4GHz),ISM(2.45GHz),INSAT(4.4-4.8 GHz) and downlink X-band satellite applications (7.25-7.75 GHz). The antenna provides the impedance bandwidth of 8%,12% and 8% respectively at the resonating frequencies. The proposed antenna achieved the multibands by placing the petals inside the circular ring. The measured results are compared with the simulated results which show good agreement with each other at the frequency point of view. The antenna is compact in size with good electromagnetic properties and good candidate for multimode terminals for integrated wireless devices.

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