VOL. 14, NO. 11, JUNE 2019 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

DUAL NOTCH UWB MONOPOLE ANTENNA WITH U-SHAPED SLOTS

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ABSTRACT

This article presents circular ring loaded multiband antenna with notch band characteristics for wireless communication applications. The antenna is in compact structure with dimensions of 21 x 28 x 1.6 mm^3 and designed on the FR4 substrate. Basically, the antenna provides the wide band characteristics and showing multiple notches. To attain the notch band characteristics, the antenna is loaded with two circular ring strips and four inverted C-shaped parasitic elements are embedded on either side of the feed line. The antenna provides maximum peak gain of 4.04 dB with efficiency of more than 78%. The proposed antenna providing notch band characteristics and showing the bidirectional and omni directional radiation patterns in E and H-Planes.

Keywords: ultra-wide band (UWB), ring loaded, notch band.

1. INTRODUCTION

The use of UWB antennas expanding quickly with its potential applications in remote correspondence frameworks and helping the high transmission rates [1]. Consequently, to keep the receiving wire transmission unaltered, architects have depended on the methodology of implanting parasitic strips of various shapes in the radio wire systems [2]. Many enhancements have been accounted for UWB applications, for example, ellipsoidal radio wire, TEM horn reception apparatus and log intermittent radio wires have been concocted. Numerous UWB receiving system would not have the capacity to accomplish more extensive radiation designs with scaled down coordinated plan [3]. Different UWB reception apparatus structures with band rejected qualities have been created, e.g., a planar UWB monopole radio wire with triple band-scored attributes dependent on a ground structure (DGS) and semi-octagon-formed resounding ring of the wire, π-formed space, curved opening UWB receiving wire with a half round about ring radiator UWB radio wire with single tri-arm resonator, have been connected for band-scoring purposes [4].

The differential UWB-MIMO reception apparatus with dismissal band of 5.1-5.95GHz has additionally been introduced by Liu *et al* [5]. Co-planar waveguide (CPW) fed low profile and broadband antenna is printed for radio wires is low gain [6]. FCC (Federal Correspondence Commission) allocated the recurrence band 3.1-10.6GHZ for various UWB bands, various UWB receiving wires have been proposed for meeting the prerequisites of wide band width, Omni-directional radiation example and conservative size [7]. In current remote correspondence systems, WLAN of 2.400-2.484 GHz(IEEE 802.11b/g)/5.15-5.35GHz/5.725-5.825 GHz (802.11 an) and overall interoperability for microwave get to WIMAX guidelines of 2.5-2.69GHz/3.4-3.69 GHz/5.25/5.85 GHz are widely connected in cell phones, for example, handheld processes and smart phones(4G phones) [8]. The consideration of UWB radio systems has been expanding quickly in UWB correspondence systems. This frame works is splendidly reasonable for trading of high data rate information [9]. Monopole radio wires are considered due to multiple benefits, for example, broad band recurrence, great radiation properties, basic structure and simplicity of fabrication [10].

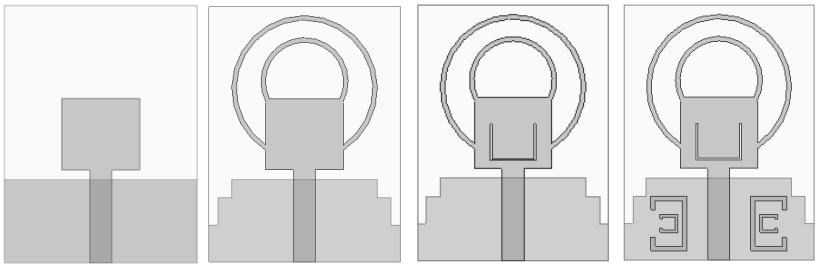
In this paper a structure of circular rings loaded antenna with multiband notched characteristics is presented for wireless communication applications by a rectangular radiating patch, a micro strip Feed line, a FR4 substrate, and a defected ground plane. In these two parasitic circular ring strips and a u-shaped slot with different widths are embedded onto the radiating patch. In these four inverted c shaped slots are placed in the both sides of the feed line. The proposed antenna is suitable for wireless wideband communication applications and C band, X band and Ku band applications

2. ANTENNA DESIGN

The geometry of the proposed antenna is shown in Figure-2. The antenna consisting of a radiating patch and microstrip feed line with defected ground structure. The radiator of the antenna is printed on a FR4 substrate with thickness of 1.6mm, a relative permittivity of =4.4 and a loss tangent of tan δ = 0. 018. The defected ground plane is carved on the opposite side of the substrate. It is shown in Figure-2(a) that a circular ring is attached to the rectangular patch. The U-shaped slot on the lower some portion of the rectangular patch, by embeddings the U-shaped slots into the rectangular patch, a higher frequency band stop channel is framed. Then again by placing the circular ring strip onto the rectangular patch a lower frequency band stop channel is additionally framed for the UWB receiving antenna.

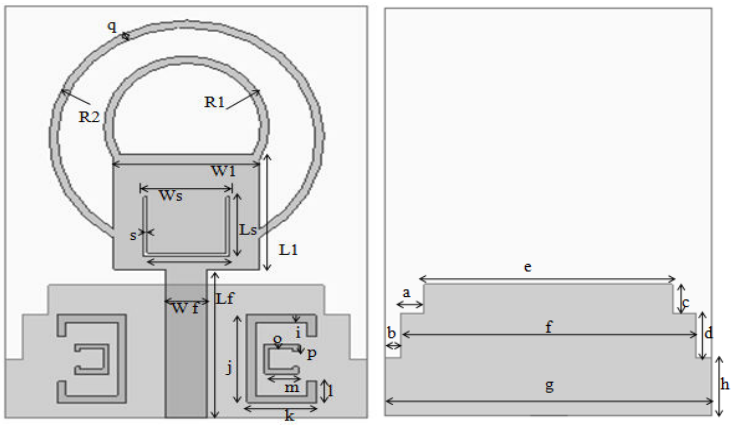
The width and length of the microstrip feed transmission line are allocated as w_f and L_f separately. It is shown in Figure-1 that the ground plane of a rectangular patch inserted with two identical inverted L slits, one rectangular slot and two circular slots. By adding the four inverted C shaped slots into the radiating patch the frequency band are increased. The defected ground plane with the three cuts can additionally expand the transmission capacity scope of 8.0 -17.5 GHz and enhance

the radiation execution. Subsequently the geometry of the proposed antenna coordinated by the U-shaped slot, C-shaped slots, the parasitic circular ring strips and the defected ground plane with various kind cuts can provide the notch band characteristics.



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

Figure-1. Iteration steps for the proposed antenna (a) Ant-1 (b) Ant-2 (c) Ant-3 (d) Ant-4 (e) Ant-5.



(a) (b)

Figure-2. The antenna physical structure: (a) top view and (b) bottom view.

Table-1. Parameters of the antenna.

Parameter	L	w	L_f	L1	W1	Ls	Ws	Lg	R1	R2	a	b	h	g
Value(mm)	28	21	10.1	2.4	7.78	4	5	9	4.8	8	1.5	1	4	21
Parameter	i	j	k	l	m	n	o	p	q	s	c	d	e	f
Value(mm)	0.5	6	2	1.5	2	2	0.3	0.5	0.5	0.2	2	3	16	19

3. RESULTS AND DISCUSSIONS

The basic rectangular patch antenna provides the wide band characteristics which are operating in the frequency range of 5.2-15.8 GHz with wide bandwidth of 10.6 GHz shown in the Figure-3. The antenna is further modified to with circular rings attached to the patch has and iterations are shown in the Figure-1. The antenna to operate with multiband characteristics which operates in the frequency of 3.9-5.4 GHz,6.8-8.2 GHz and 8.9-12.5 GHz with bandwidths of 1.5 GHz, 1.4GHz, 3.6GHz which covers the many wireless applications like WLAN, WiMAX, X-band applications. To improve the notch band characteristics the antenna is further modified with U shaped slot on the patch. The antenna 3 provides the single notch characteristics from7.9-9.4 GHz. Finally, the rectangular rings are added in the either side of the feed line to get 2 notch band characteristics which are ranging in the frequency of 7.4-9.09GHz and 12.6GHz-13.4 GHz.

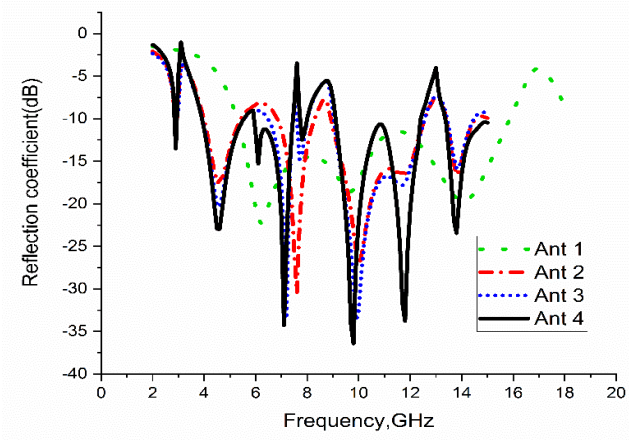
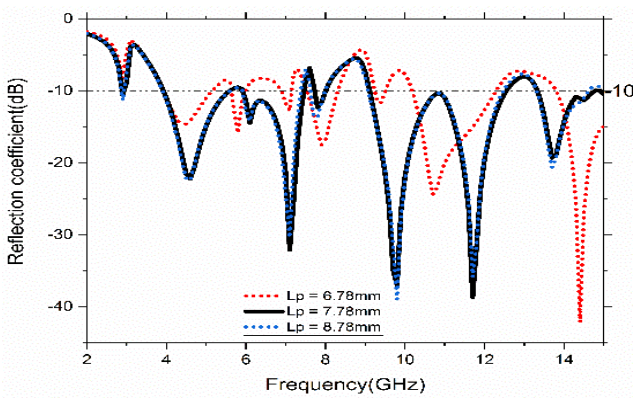


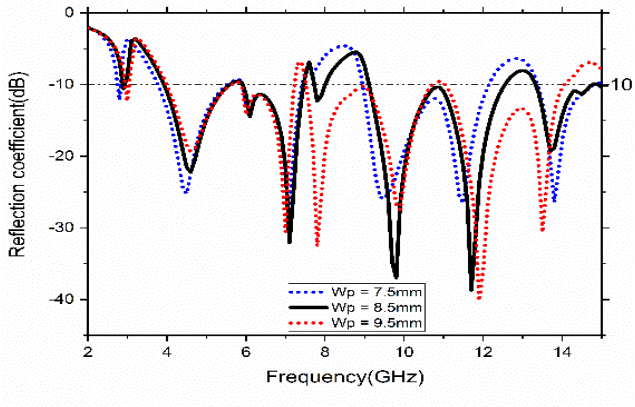
Figure-3. Reflection coefficient of the iterations of the antenna.

3.1 Parametric study

To obtain the optimised parameters of the antenna parametric study is carried out. It has been observed that the working frequency band and its band-notched characteristics of the antenna are mostly determined by the size of the U-shaped slot (s, Ls,), the parasitic circular ring strips (R_1, R_2), micro strip feed line (w_f) and the defected ground structure. Figure-4 demonstrates that the simulated return loss of the proposed antenna fluctuates with various geometrical structure and parameters. The proposed antenna produces the notch frequency band of 5.0 - 6.0 GHz; this notch band is because of U-shaped slot inserted into the rectangular patch. It demonstrates that the U-shaped opening is a key factor for producing the frequency notch band. Furthermore, the frequency band moves from a higher frequency to a lower frequency with the increasing of the parameters and Ls. As it were, the circular ring strip is utilized to produce the frequency band for the antenna. Figure-4(b) demonstrates that the reproduced return loss of the proposed antenna is impacted by the varying of patch lengths from 6.78 to 8.78 mm. As appeared in Figure-4(c) shows that the return loss of the antenna by changing the width of the patch from 7.5 to 9.5mm. Figure-4(d) demonstrates that the simulated return loss of the receiving antenna is influenced with the radius of the circle1 is changed from 3.8mm to 5.8mm.



(a)



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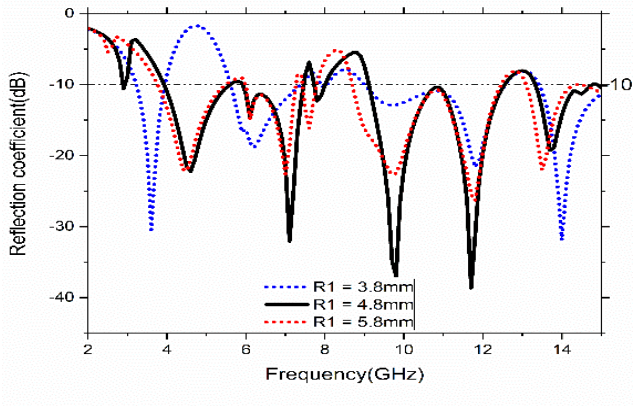
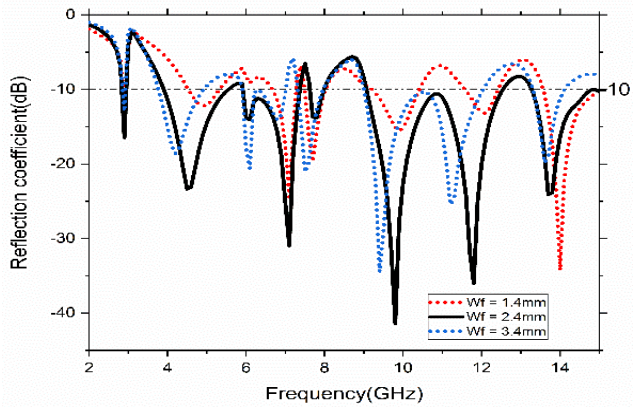


(c)



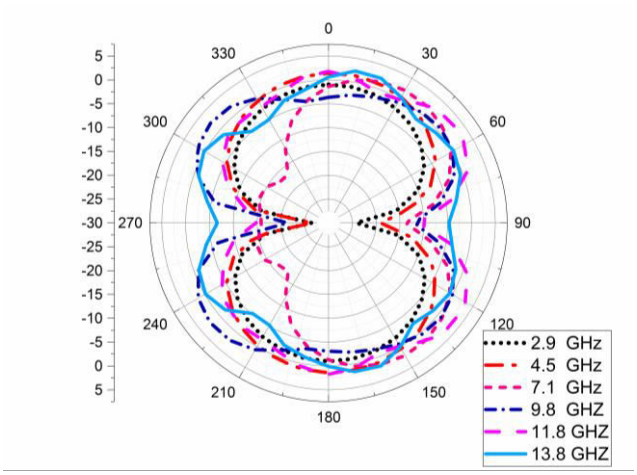
(d)

Figure-4. Parametric analysis by varying the different parameters.

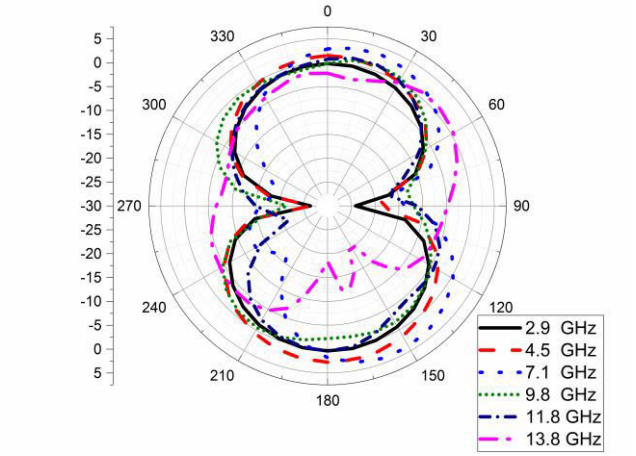
3.2 Radiation patterns

The radiation patterns for the proposed antenna are illustrated in the Figure-5. The radiation patterns are represented in the XY-Plane, YZ-Plane and ZX-Plane approach. In Figure-5(a) the pattern in XY-Plane for different frequencies such as 2.9 GHz, 4.5 GHz, 7.1 GHz, 9.8 GHz, 11.8 GHz, and 13.8 GHz are shown.It is observed that the radiation patterns of the designed antenna are bidirectional in XY,YZ- plane shown in

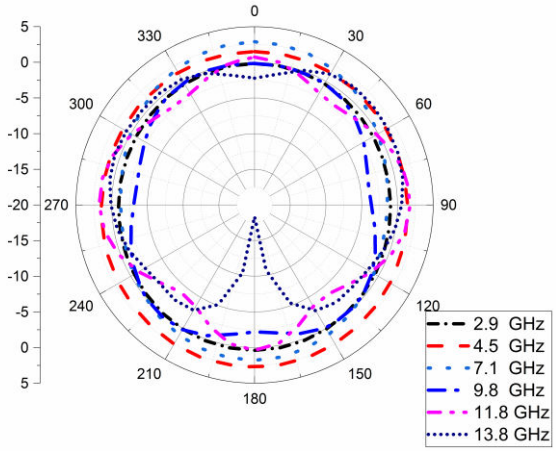
Figure-5(a) and 5(b). The radiation patterns of the designed antenna are omnidirectional in ZX plane shown in Figure-5(c).



(a)



(b)



(c)

Figure-5. Radiation patterns of the proposed antenna (a) XY-plane (b) YZ -plane(c) ZX-plane.

3.3 Surface currents

The surface of the proposed antenna at 2.9, 4.5, 7.1,9.8,11.8 and 13.8 are shown in Figure-6. As shown in Figure-6(a), it is observed that the surface current moves on the feed line when the proposed antenna operates at 2.9GHz and directed between the left and the right parts of the patch. Similarly, it is shown in Figure-6(b) that the current flows are relatively concentrated on the feed line when the proposed antenna operates at 4.5GHz and directed between the interior and exterior parts of the slot. As shown in Figure-6(c), it is observed that the current flows are more around the patch and slightly entered the circular strips when the antenna operates at 7. 1GHz.In Figure-6(d) shows that the current flows from the patch to the feed and entered the mini circular ring strip. As shown in Figure-6(e), it is observed that the current flows around the feed at 11.8GHz. In Figure-6(f) shows that the current flows around the feed and slightly entered the c shaped slots and the circular ring strips at 13.8GHz.

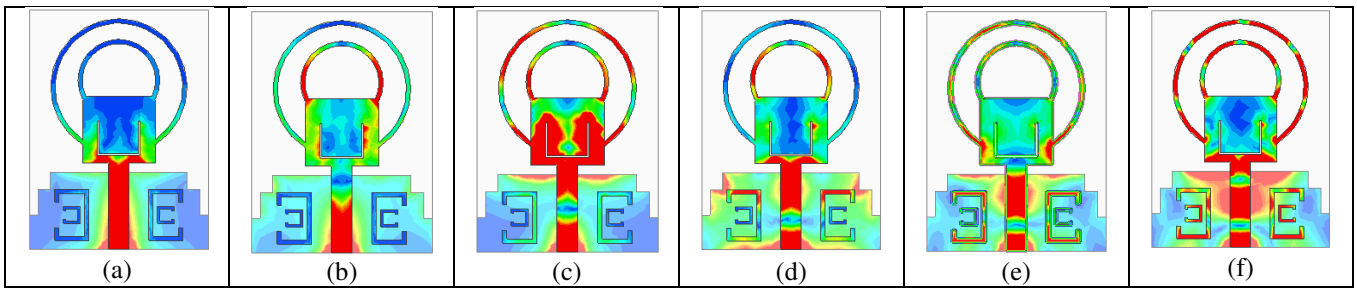


Figure-6. Simulated current distributions on the radiating patch:(a)2.9GHz, (b)4.5GHz (c)7.1GHz, (d)9.8GHz, (e)11.8GHz (f) 13.8GHz.

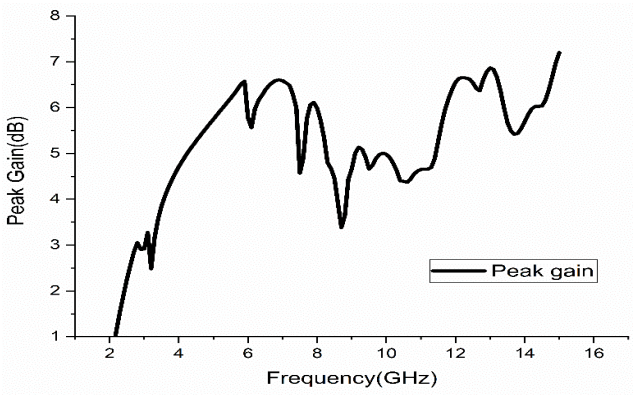


Figure-7. Peak gain of the proposed antenna.

The peak gain of the proposed antenna is noted at the resonating frequencies of the antenna shown in Figure-7. The antenna provides the peak gain of 0.4 dB at 2.9 GHz, 2.7 dB at 4.5 GHz, 4.04dB at 7.1 GHz 2.4dB at 9.8 GHz, 3.7dB at 11.8 GHz and 2.9dB at 13.8 GHz. in the notch frequencies antenna provides the less than 2dB peak gain.

4. CONCLUSIONS

In this ring loaded rectangular patch antenna is presented for the dual notch band characteristics. The U-shaped slot on the feed line and concentric rectangular rings on the either side of the feed line is responsible for the rejection of the frequency bands which are ranging from 7.40-9.09 GHz and 12.6-13.4 GHz to avoid the interference with X-band applications. The antenna covers the frequency ranging from 3.8-5.5 GHz, 5.9-7.4 GHz 9-12.5 GHz. with fractional bandwidth of 36.5%, 22.5%, and 32% respectively. The antenna is compact in size with bidirectional and omni directional radiation patterns which are suitable for various wireless applications.

ACKNOWLEDGEMENTS

We express our gratitude to ECE of KLEF and DST through EEQ/2016/000604 and ECR/2016/000569 for their technical support.

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