CPW fed Arc loaded Monopole Antenna; Design and Analysis

Nagageetha Mamilla,

Abstract*: *A novel asymmetric grounded coplanar waveguide (CPW) circular patch antenna with arcs loaded are presented for multiband applications. This antenna is formulated of a monopole, extended circle, arcs loaded and asymmetrical ground planes. This structure excites at four frequencies such as 2.38GHz, 3.40GHz, 7.66GHz and 8.95GHz with impedance bandwidths are 160MHz (2.30-2.46GHz), 90MHz (3.35-3.44GHz), 7.66GHz (7.00-7.91GHz) and 630MHz (8.62-9.25GHz). The radiation characteristics at the centered frequencies are closer to Omni-directional patterns. Although this proposed structure resonant frequencies could be easily adjusted to some commercial applications like LTE, Bluetooth, GPS, WLAN, broadband communications and satellite communication.

Index Terms: CPW-fed, Asymmetric grounds, Arcs loaded, multibands, omnidirectional.

I. INTRODUCTION

The process of exchanging of information between two or more points in the absence of physical connection is known as wireless communication. The microstrip patch antennas are an important entity in RF wireless product and is low profile planar configuration and has less space utilization and having light weight, these are integrable easily with monolithic integrated circuit. In this linear and circular polarization is possible with simple feed [1-2].

In terms of having a thick substrate is realized when you fabricate coplanar wave guide (CPW) MMIC'S. Many examples of high isolation have used grounded CPW to get dB isolation or more. These are the active designs can be mounted on top of the circuit. It provides extremely high frequency response (100GHz or more). Simple realization achieved due to etching on one side of dielectric material [3-5][13-16].

In this work, circular patch antenna is designed with concentric circular slot on the surface of patch. The complete study is arranged into following sections and explained. Section 2 explains the design process and design values of respective parameters presented in tables. Section 3 describes the results and discussion comparison shown in tables. Sections 4 is ended with conclusion and section 5 contains references.

II. CIRCULAR PATCH ANTENNA CONFIGURATION AND ITS RESULTS

Initially the circular patch antenna designed having antenna dimensions 21mm x 25mm is considered with asymmetrical coplanar wave guide (CPW) feeding. Top view of P shaped patch antenna is depicted in figure 1. The circular aperture in P shaped antenna is designed using equations 1 to 3 [6-8].

Error! Reference source not found. (1)

Where **Error! Reference source not found.** (2)

Using equation (3), effective radius can be calculated

Error! Reference source not found. (3)

Where a = circular patch antenna radius

h= height of the substrate, mm

ε_r = dielectric constant

Table I: Design parameters values (All units are in mm)

L_{sub}	W_{sub}	L_f	W_f	L_1	L_2	G	G_1	G_2
25	21	16	1.5	9	7.5	0.5	4	14.5
D	R_1	R_2	R_3	R_4	R_5	R_6	L_3	S
7	7	6	5	4	3	2	22	1

The simulated results of asymmetric CPW fed P-shaped patch antenna are shown below. Figure 2 is depicting the reflection coefficient characteristics of circular antenna. This antenna having wide impedance bandwidth of 2.21GHzto cover 4.68-6.89GHz range. Figure 3 showing the VSWR characteristics of P shaped antenna. From graph it can be concluded that the VSWR is with in 2:1 limit at the resonant frequency. The significance of figure 3 is circular patch antenna obeys perfect impedance matching property. The far field reports of P-shaped antenna are presented in figure 4. Figure 4(a) depicting the 3D gain polar plot with maximum peak gain of 3.1dB with omnidirectional characteristics. Figure 4 shows the radiation characteristics of this antenna.

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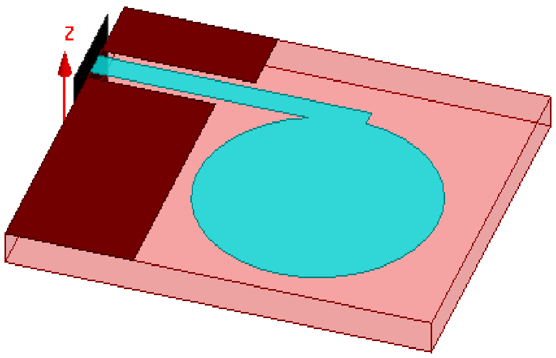
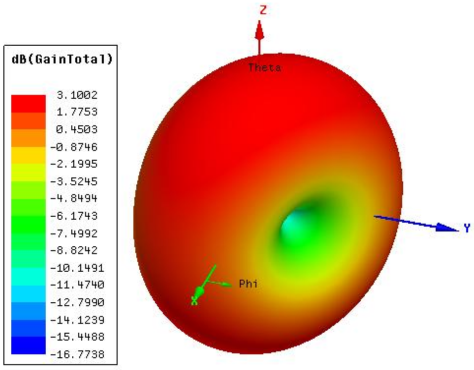
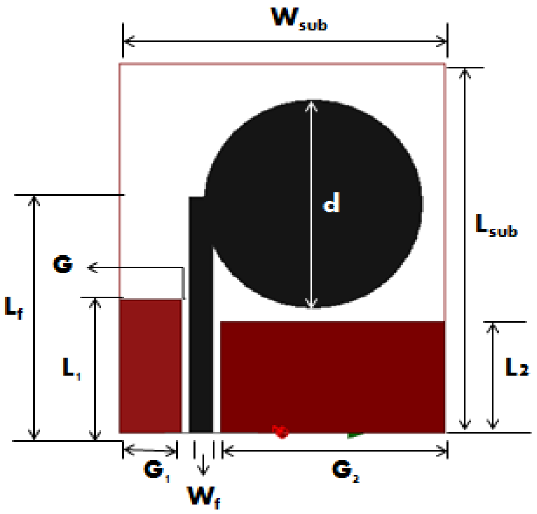
Nagageetha Mamilla, Assictant Professor, Dept of ECE, CMR Institute of Technology, Kandlakoya, Hyderabad, T.S



a) 3D model view

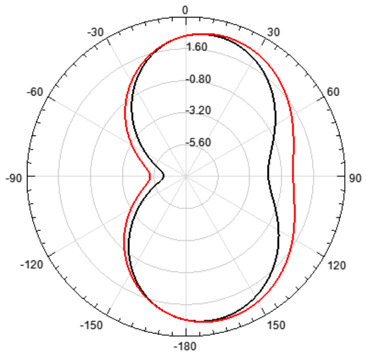


a) 3D gain plot



b) top view

Fig 1: Design of P shaped antenna.



b) Radiation pattern

Fig 4: Far field reports of p-shaped patch antenna

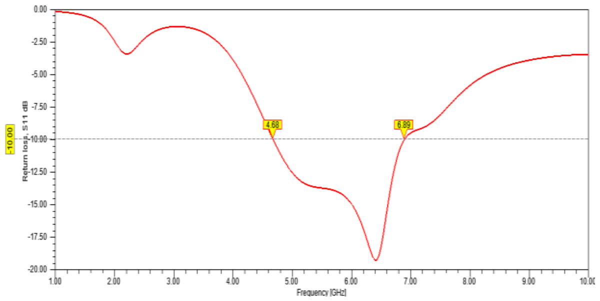


Fig 2: Scattering parameters of P-shaped patch antenna.

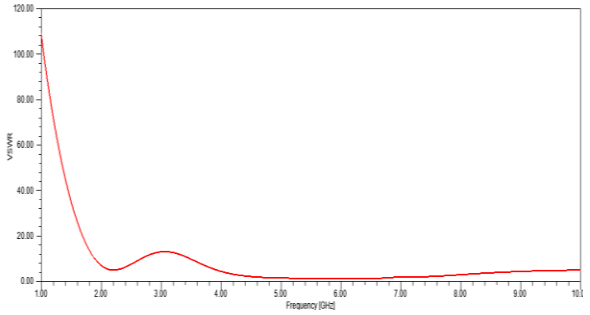


Fig 3: VSWR of P-shaped antenna.

III. MULTIBAND ANTENNA DESIGN CONFIGURATION AND ITS RESULTS

Many technologies have been implemented for multiband applications including various feed methodologies [9], slots loaded on radiating element [10], adding stubs to the patch [11] and fractal technologies [12].

The antenna – 1 shown in figure 5(a) is a monopole antenna having a circular patch. This resembles like a capacitive loaded radiating structure. Figure 5(b), is showing monopole antenna loaded with circular ring. Multiple resonance can be achieve by continuing slots on the aperture of patch. Final design shown in figure 6 resonates at four different frequencies and corresponding design invariable are presented in table I.

Figure 7 shows the performance behavior of all these antenna structures. Figure 8 shows the proposed antenna electrical characteristics. This antenna resonates at four wide frequency bands. This antenna centered at 2.38GHz with return loss -26.91dB, 3.40GHz with return loss -18.25dB, 7.66GHz with -26.06dB and 8.95GHz with -15.59dB. The simulated -10dB impedance bandwidths are 160MHz over 2.30-2.46GHz, 90MHz over 3.35-3.44GHz, 7.66GHz over 7.00-7.91GHz and 630MHz over 8.62-9.25GHz respectively. The corresponding VSWR values at those resonant frequencies are 1.09, 1.27, 1.10 and 1.39 respectively. The VSWR characteristics are also shown in figure 8. Several applications covered by these bands are shown in table II.

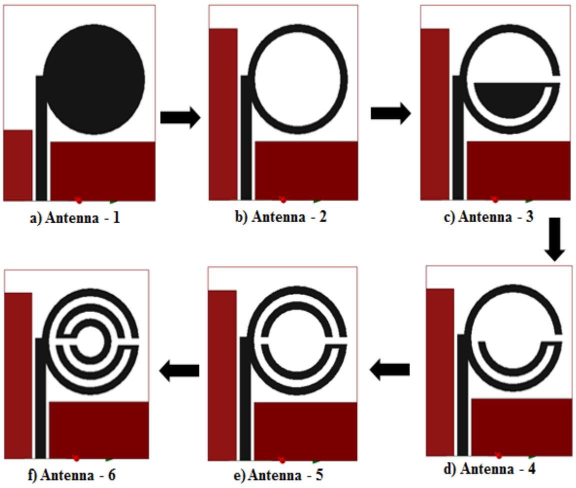


Fig 5: Proposed antenna design implementation steps

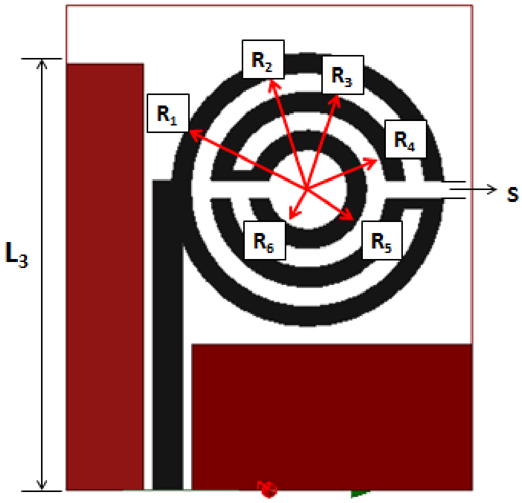


Fig 6: Parameters described on design

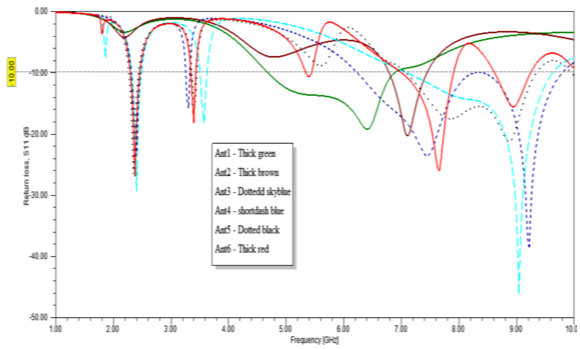


Fig 7: Reflection coefficient verses frequency at various iterations.

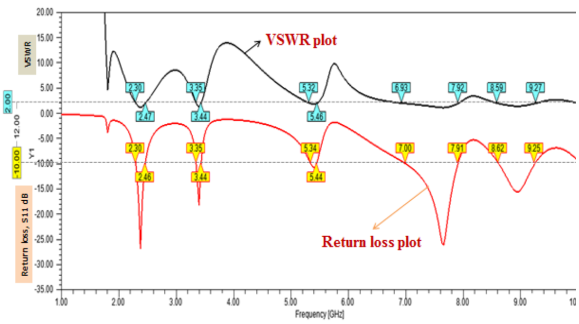
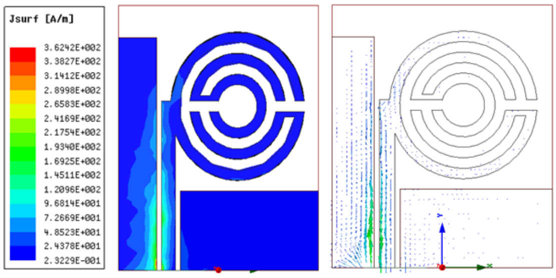
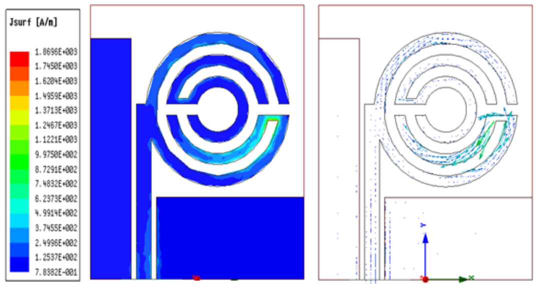


Fig 8: Final design VSWR and Return loss characteristics.

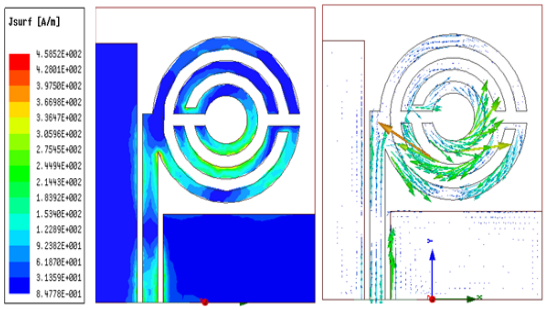
The magnitude and vector surface current distributions of designed antenna at various resonating frequencies are shown in figure 9. From figure 9, at lower resonant frequencies the outer edges of radiating elements having more current distribution. As frequencies increases the current distribution becomes more at internal concentrated rings.



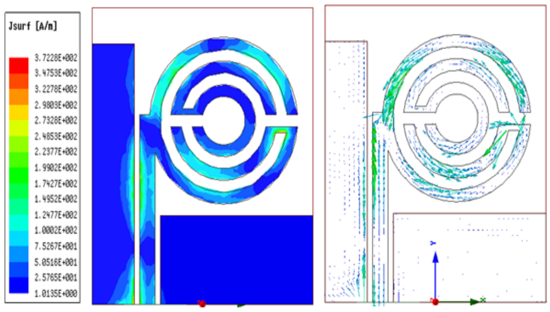
a) 2.38GHz



b) 3.40GHz



c) 7.66GHz



d) 8.95GHz

Fig 9: Both magnitude and vector surface current distribution of designed antenna.

The simulated results of far field of final design are presented in figure 10 and figure11 respectively. Figure 10 shows the 3D gain plot at resonant frequencies 2.38GHz, 3.40GHz, 7.66GHz and 8.95GHz with maximum peak gains are 2.76dBi, 1.38dBi, 2.03dBi and 1.81dBi respectively.

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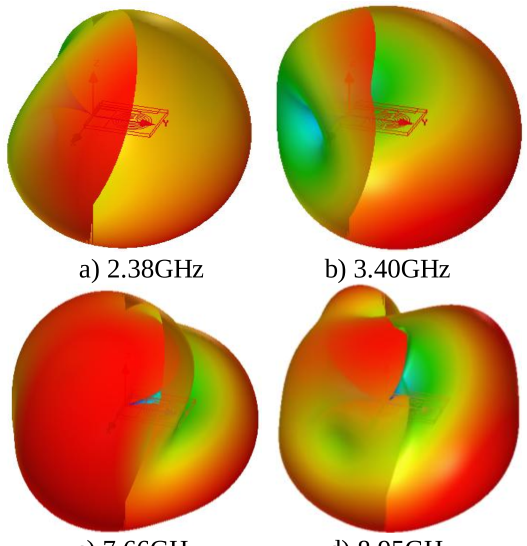
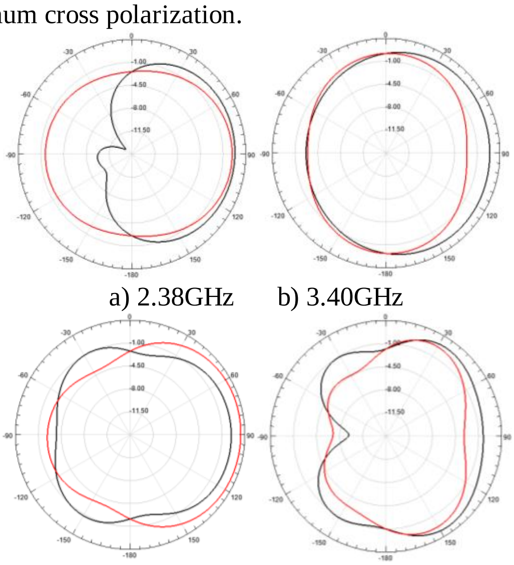


a) 2.38GHz b) 3.40GHz

c) 7.66GHz d) 8.95GHz

Fig 10: 3D gain plot of designed antenna.

Final design E and H plane pattern are presented in figure 11. Omnidirectional patterns are achieved at all bands with minimum cross polarization.



a) 2.38GHz b) 3.40GHz

c) 7.66GHz d) 8.95GHz

Fig 11: Radiation patterns of finalized antenna design (Red – Co-polarization & Black – Cross polarization)

IV. CONCLUSION

The asymmetric grounded monopole antenna loaded with arcs is designed and its results are presented in current paper. The architecture is simulated in HFSS, where size of antenna is 25mm x 21mm. This antenna resonates at four frequencies corresponding peak gains are 2.76dB, 1.38dB, 2.03dB and 1.81dB respectively. This antenna is suitable to cover S- , C- and X- band applications.

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