Investigations on CPW fed Hexagonal shaped UWB Antenna for Triple and Penta band Applications

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Abstract*: Hexagonal patch antenna with coplanar wave guide (CPW) feed working with in ultra wide band (UWB) range. Its hexagonal aperture is altered to spiral fork shaped then resultant structure is producing triple bands at 1.36GHz, 5.74GHz and 8.8GHz. When ground of basic antenna is altered then resultant structure is producing penta bands at 2.38GHz, 3.64GHz, 6.76GHz, 7.36GHz and 8.98GHz. Corresponding impedance band widths are 200MHz, 70MHz, 170MHz, 520MHz and 420MHz and peak gains are 1.77dB, 2.45db, 3.53dB, 4.54dB and 2.28dB respectively. These antennas are suitable for S - , C - and X - band applications.

***Index Terms*: Spiral fork shaped antenna, CPW feed, UWB, Triband, Pentaband, Peak gain.**

I. INTRODUCTION

The raise in technology, demanding compact and multi functioning antennas which supports data and voice simultaneously [1]. Most suitable printed usually choose for study is patch antenna because of its several advantages such as lower in size, low volume, and cheaper in cost[2]. These structures operates at number frequencies with polarization reconfiguration by small alterations on its structure [3-7].

Current study, considers hexagonal aperture antenna with CPW feeding. The UWB antenna design methodology and its working principles are explained in section II. Section III explains the triband antenna design. In section IV penta band structure is presented. The results obtained in HFSS software are illustrated in section V. The performance results of various designed antennas are described in section VI. And section VII is ended with conclusion.

II. UWB ANTENNA & DESIGN METHODOLOGY

Initially hexagonal shaped antenna is etched on FR4 epoxy substrate of stature 1.6mm [12-14]. The size of completes structure is 28mm x 28mm x 1.6mm.

Figure 1 shows the designed hexagon microstrip antenna design. In this design CPW feeding method used for wide band (3.1-10.6GHz) to cover UWB wireless applications. The simulation results of this design are shown and explained in section V.

The side length L_1computed from the rectangular microstrip antenna design area. This can be expressed as

$$Rectangular\ microstrip\ antenna\ area = \frac{3\sqrt{3}}{2}{L_1}^2 \quad \ldots (1)$$

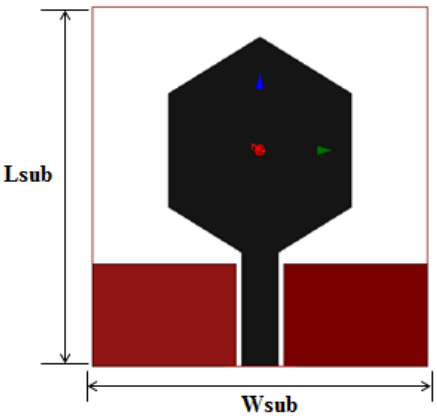

Fig 1: Hexagonal shaped Microstrip antenna design

III. DESIGN OF TRIBAND ANTENNA

Multiband antenna is necessary in some wireless communication streams. In the literature reviews, multiple resonances can be produced by PIFA antennas [15], modified circle shaped antenna [16], Log periodic array antennas [17] and modified triangle antennas [18] etc.

To achieve tri band characteristics, the hexagon shape is modified into U-shape with long stubs and it will consider as first iteration, which is presented in figure 2(a). Second and third iteration structures are presented in figure 2(b) & (c). Finally, antenna – 3 resonates at three different resonant frequencies. All the simulated resulst are depicted in section – V. The design parameters of designed antennas are represented in figure 2(c). All these parameters are described in table I.

Table I: Parameters depicted on figure 2 (All the units are in mm)

L_{sub}	W_{sub}	L_g	L	W_g	W_f	L_1
28	28	7	2	11.5	3	8.8
g	**g1**	**t**	W_{f2}	W_{g1}	**L2**	**L3**
1	1	0.85	2.5	12	8	6

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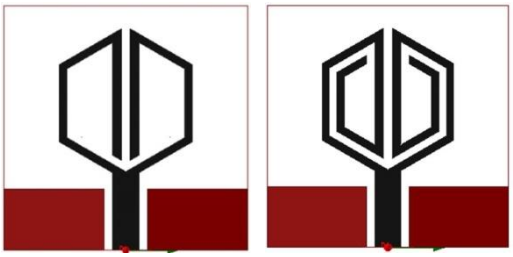
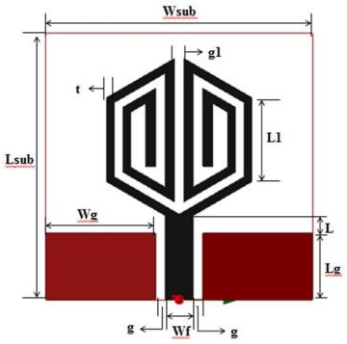


(a) Antenna – 1 (b) Antenna – 2



(c) Antenna – 3

Fig 2: Implementation of tri band antenna

IV. DESIGN OF PENTA BAND ANTENNA

With slight modifications in the tri band antenna design, it starts resonating at five frequencies with good radiation pattern characteristics. Modified penta band architecture is depicted in figure 3. Parameters mentioned on design are shown in table I.

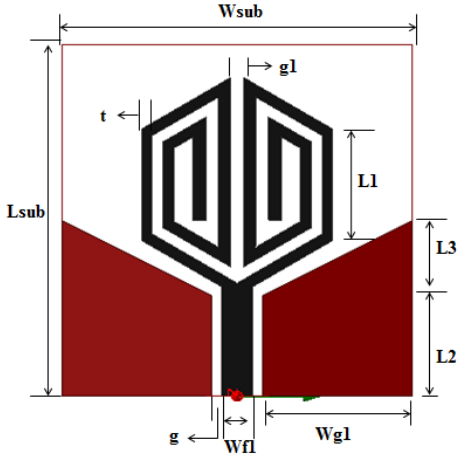


Fig 3: Pentaband antenna design top view

V. SIMULATION RESULTS AND DISCUSSION

A. UWB antenna results

Figure 4 depicting the return loss characteristics of hexagon aperture antenna. This structure covers a wide range of bandwidth over 3.15-10.75GHz with good reflection coefficient. The VSWR characteristics is presented in figure 5, where as far field pattern are reported in Figure 6 & 7.

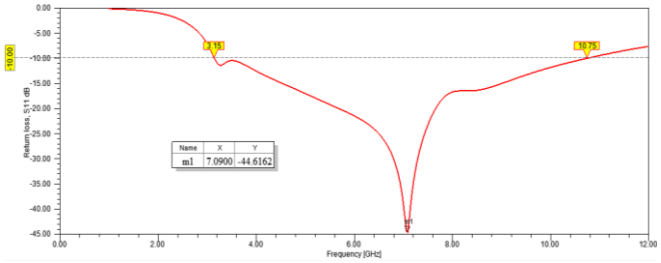


Fig 4: Scattering parameters of UWB antenna

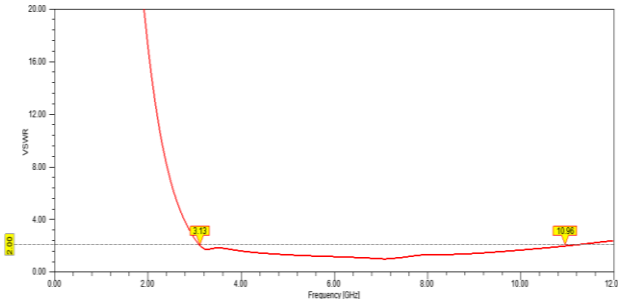


Fig 5: VSWR characteristics of UWB antenna design

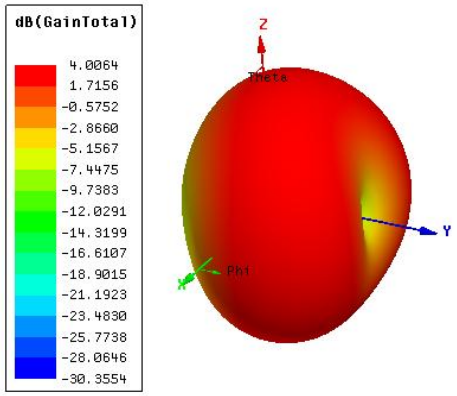


Fig 6: 3D gain plot

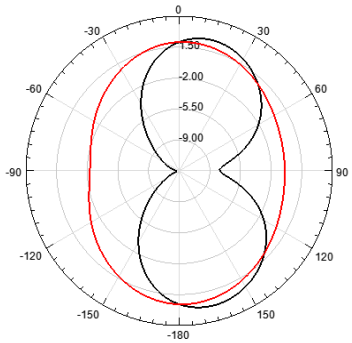


Fig 7: E - plane (red) & H-plane (black) pattern

B. Triband antenna results

Return loss at port of three designs is presented in Figure 8. It is showing that antenna -3 is resonating at three frequencies, they are 1.36GHz, 5.74GHz and 8.80GHz with impedance bandwidths are 20MHz, 1.68GHz, 570MHz respectively.

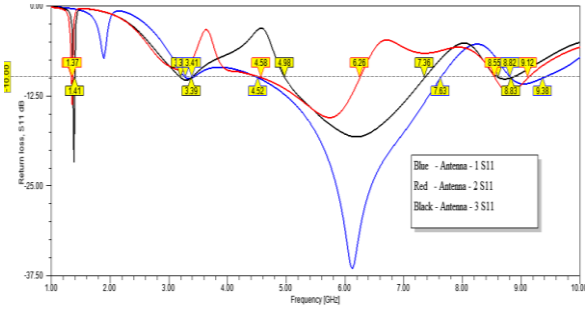


Fig 8: Return loss characteristics comparison between antenna – 1, 2 & 3.

C. **Pentaband antenna results**

By changing the slight modifications in antenna – 3, a new structure has been introduced. It resonates at five frequencies such as 2.38GHz, 3.64GHz, 6.76GHz, 7.36GHz and 8.98GHz with their corresponding bandwidths are 200MHz, 70MHz, 270MHz, 520MHz and 420MHz respectively is presented in figure 9 and 10.

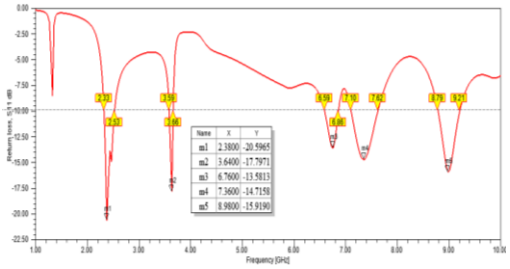


Fig 10: Return loss characteristics of pentaband antenna

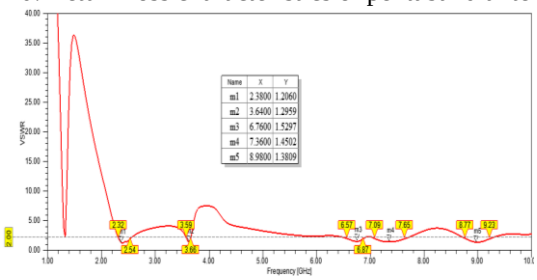
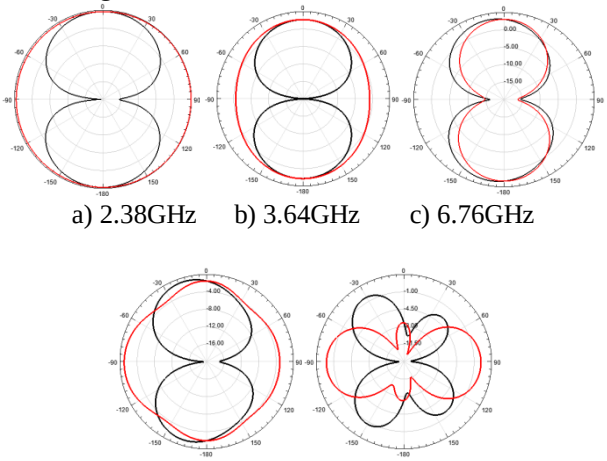


Fig 11: VSWR characteristics of penta band antenna

The corresponding gains at their resonant frequencies are 1.77dB, 2.45dB, 3.53dB, 4.54dB and 2.28dB respectively.

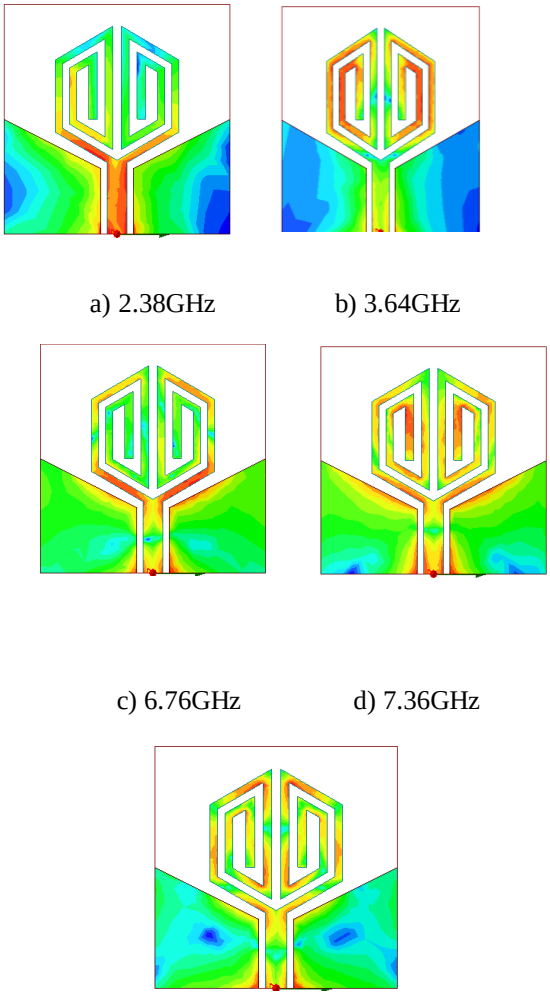
The radiation patterns at these resonant frequencies are shown in figure 12.



a) 2.38GHz b) 3.64GHz c) 6.76GHz

d) 7.36GHz e) 8.98GHz

Fig 12: E - plane (red) & H-plane (black) pattern at five working frequencies.



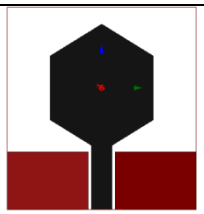
a) 2.38GHz b) 3.64GHz

c) 6.76GHz d) 7.36GHz

e) 8.98GHz

Fig 13: Surface current distribution at five frequencies.

Table II: UWB, Triband and Pentaband antenna performances

S.No	Design model	Application	f_r, (GHz)	Impedance bandwidth	S11 dB	VSWR	Max. peak gain
1		UWB	7.09	3.15-10.75GHz = 7.60GHz	-44.61	1.01	4.04dB
2		Triband	1.36	1.35-1.37GHz = 20MHz	-13.77	1.51	2.93dB
			5.74	4.58-6.26GHz = 1.68GHz	-15.53	1.40	3.19dB
			8.80	8.55-9.12GHz = 570MHz	-13.17	1.65	3.72dB
3		Pentaband	2.38	2.33-2.53GHz = 200MHz	-20.59	1.20	1.77dB
			3.64	3.59-3.66GHz = 70MHz	-17.79	1.29	2.45dB
			6.76	6.59-6.86GHZ = 170MHz	-13.58	1.52	3.53dB
			7.36	7.10-7.62GHz = 520MHz	-14.71	1.45	4.54dB
			8.98	8.79-9.21GHz = 420MHz	-15.91	1.38	2.28dB

VI. CONCLUSION

In this paper, simple architectures which can produce triple bands (i.e., 1.36GHz, 5.74GHz and 8.50GHz) and penta bands (i.e., 2.38GHz, 3.64GHz, 6.76GHz, 7.36GHz and 8.98GHz with peak gains 1.77dB, 2.45db, 3.53dB, 4.54dB and 2.28dB) is obtained from fundamental hexagonal aperture CPW fed UWB antenna. These architectures are suitable for S-, C- and X- band wireless applications.

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