ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 4, Issue 12, December 2015

Design of Triangular Monopole UWB Microstrip Patch Antenna with SRR

[1]Pawan Kumar, [2]D.K.Srivastava

Abstract*: In this paper, method of moments based IE3D software is used to design a Triangular Monopole UWB Microstrip Patch Antenna with Split ring resonator. The aim of the paper is to design a wide band and Multiple Band rectangular Microstrip Patch antenna with split ring resonator. To studies the effect of split ring resonators on bandwidth for particular substrate thickness and dielectric constant on antenna. The length of the antenna is nearly half of wavelength. It is a very critical parameter which governs the resonant frequency of the antenna. In view of design, selection of the patch width and length are the major parameters along with the feed point. A triangular monopole patch designed with SRR and without SRR on the ground plane. The proposed antenna is excited using coaxial probe feeding method. Antenna resonate at 3.642 GHz with return loss -27.2 dB and bandwidth 50.61% for VSWR≤2, maximum gain is 3.28dBi at 3.71GHz and maximum directivity is 6.60dBi at 5.73GHz. When ground plane is replaced with slit ring resonator, it gives multiple band due to creation of band pass filter by SRR. It gives triple bands. The proposed antenna was fabricated and experimentally verified for wideband and multiple band performance. The Proposed antenna is small and suitable for wireless portable device and wireless communication.

***Keywords*: Microstrip triangular antenna, SRR, design, bandwidth, efficiency.**

Manuscript received December, 2015

***Pawan Kumar**, Department of Electronics and Communication Engineering, Bundelkhand Institute of Engineering and Technology Jhansi-284128.*

***D. K. Srivastava**, Department of Electronics and Communication Engineering, Bundelkhand Institute of Engineering and Technology, Jhansi-284128.*

I. INTRODUCTION

Microstrip antennas satisfy the demands for small size, low weight installation in various devices with lack of space like mobile phones. Antennas are used in a moving device such that mobile, aircraft, satellite, missile etc. Square, rectangular and circular are the most common shape for microstrip antenna. Microstrip patch antenna in a simplest form consist of a sandwich of two parallel conducting layer separated by a single thin dielectric substrate [1]. A microstrip patch antenna consist of a metallic radiating patch on one side of dielectric substrate, which has a ground plane on opposite side and most common shapes used as simple antenna are rectangular, triangular and circular patch antenna.

Patch antennas are commonly used in the communications industry due to a various advantages. First, the directivity, gain and bandwidth parameter make it optimal for communications. Secondly, they exhibit Omni directional performance. Patch antennas are easily analyzed with a variety of different models such as the transmission line mode, and cavity models. The main shortcomings of these antennas are narrow bandwidth and low gain. These shortcomings can be overcome in by proper design of an antenna, and especially by using proper substrate thickness and dielectric constant as well as proper way of feeding [2]. Relation between dielectric constant and resonance frequency of a microstrip antenna can be written as:

$$\frac{\delta f}{f_r} = -\frac{1}{2}\frac{\delta \varepsilon_r}{\varepsilon_r} \quad (1)$$

f_r is the resonate frequency, δf is the change of resonance frequency and $\delta\epsilon_r$ is the change in dielectric constant, ε_r is the dielectric constant. Change in the size of the patch antenna result in the change in the resonance frequency where,

$$\frac{\delta f}{f_r} = -\frac{\delta w}{w} \quad (2)$$

δw is the change in the patch width, w is the patch of width, w is usually in the range $\lambda_o/3 < W < \lambda_o/2$, ratio of L/W>2 is not advised, L is the path of length. Thickness of the dielectric constant substrate is less effective on the resonance frequency compared to dielectric constant, $0.003\lambda_o \leq h \leq 0.1\lambda_o$ is generally used [3].

II. DESIGN ASPECT

For designing a perfect antenna there are certain parameters that are to be considered that define the configuration of the antenna such as, return loss, gain, directivity, bandwidth, radiation pattern, input impedance, radiation efficiency, feed point location, smith chart and so on. Parameter in the software for the responses and simulation are Dielectric constant of the substrate (4.2), loss tangent (0.0013), thickness of the substrate (1.6mm) and highest frequency (6GHz). Return loss is the best method to calculate the input and output of the signal source. When the load is mismatched the whole power is not delivered to the load there is a return of the power and that is called return loss. During the process of design of microstrip triangular UWB microstrip patch antenna. There is a response taken from the magnitude of return loss Vs frequency shown in fig.2. Proposed antenna has minimum return loss at 3.642GHz.

Bandwidth is the range of frequency that the antenna will radiate efficiently where the antenna meets a certain set of specification performance criteria. To determine the bandwidth on the input return loss graph, the difference in frequency is taken at the points where the curve cut the -10dB level, the difference that divided by the resonant frequency to give the percentage bandwidth. The directivity of an antenna can be defined as "the ratio of the radiation intensity in given direction from the antenna to the radiation intensity averaged in all the direction" [4]. The directivity of the antenna depends on the shape of the radiation pattern. Another parameter is gain describes the performance of the antenna that is ratio of radiation intensity in a given direction to the radiation intensity that would be obtain if power accepted by the antenna were radiated equally in all directions (isotropic), Gain of proposed antenna is shown in fig.4. Radiation pattern of spiral antenna is shown in fig.3 and it can be said that the power radiated or received by the antenna is the function of angular position and radial distribution from the antenna.

Here, in this paper ground substrate of length 40mm and width of 30mm. patch hieght from ground is taken 1.6mm. The proposed antennas designed with split ring resonator and without SRR. Without SRR, I obtained a wide bandwidth and with SRR obtained triple narrow bandwidth. Split ring resonator creates a strong magnetic coupling with applied electromagnetic field [5]. Due to it can support resonant wavelength much longer than the diameter of the rings. This would not happen in closed rings small gap produced large capacitance value which lower the resonant frequency. Split ring resonator has high quality factor and low radiation losses. Detail specification of proposed antennas is given in table 1[6].

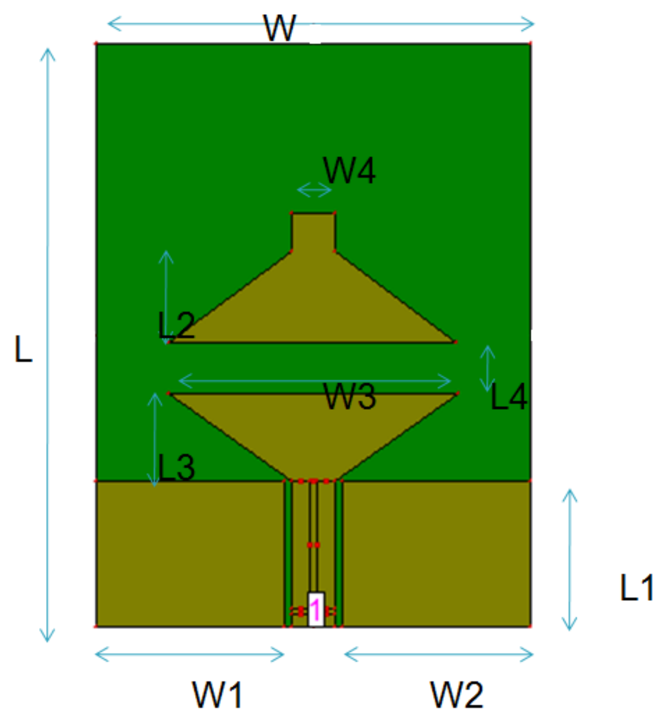


Fig.1: Top view of Triangular Monopole Microstrip Patch Antenna

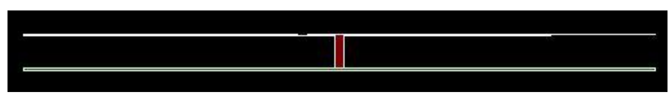


Fig.2: Side view of Triangular Monopole Microstrip Patch Antenna

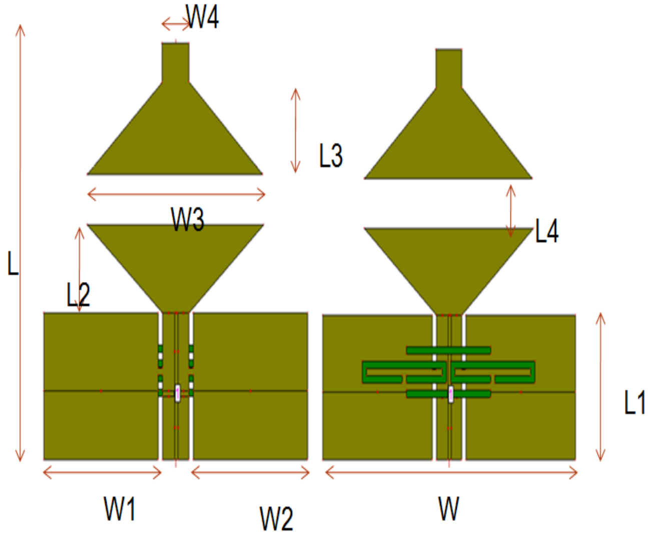


Fig.3: Top and Back view of Triangular Microstrip Patch Antenna with SRR

TABLE: 1

DIMENSIONS OF THE DESIGNED ANTENNAS

S. No.	Parameters	Values
1.	Resonance frequency f_r	3.643 GHz
2.	Dielectric constant ε_r	4.2
3.	Substrate height h	1.6 mm
4.	Patch width W	30 mm
5.	Patch length L	40mm
6.	W1=W2	13 mm
7.	W3	20mm
8.	W4	3mm
9.	L4	4mm
10.	L1	10mm
11.	L2=L3	6mm

A rectangular type split ring resonator [11] designed with l1=10mm, l2= 4.5mm, l3=3mm, d=0.5mm and width of strip is 1mm

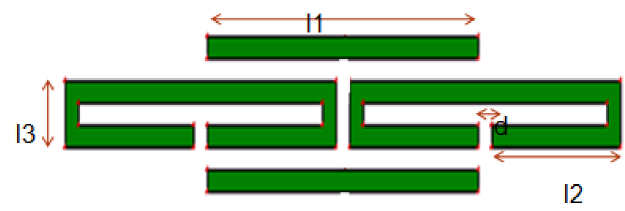


Fig.4: Split Ring Resonator

III. RESULT AND DISCUSSION

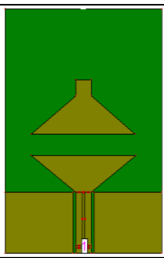
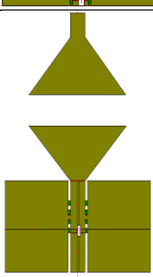
IE3D software is first scalable design and verification platform. It is used for designing antennas, MMICs, RFID, IC Packaging and PCBs. IE3D by Zeeland Simulation Software, Inc. is simulation program that serves to analyze and optimize generally planar structures with possibility to model 3D metallic structures [7]. The IE3D is a full-wave, method of moment (MOM) simulator solving the current distribution on 3D and multi-layered structures of general shape. Some of IE3D simulation results are Return loss, VSWR, Gain, Directivity, Smith chart, 2D and 3D Radiation pattern and so on. Antennas with known shape can thus be optimized. It contains complete information about antenna geometry (A part geo file is on appendix). And IE3D form sp, log, and cur and pat file. Sp file contains information about s- parameter, cur file about current distribution and pat file about radiation pattern, log file contains information about simulation.

In this paper, in the chart as shown below proposed antennas configuration A gives the maximum bandwidth for triangular monopole patch[10] so that for further process of my paper, I used this patch size as base[8], for this shape lower frequency is 3.303 GHz, upper frequency is 5.541 GHz and fractional bandwidth is comes out of 50.61 %. Next step is selection of the shape of ground plane with split ring resonator which gives the narrow bandwidth [9], if patch size and shape of ground is replaced with SRR, obtained triple bandwidth in range of 3GHz to 6GHz.

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 4, Issue 12, December 2015

TABLE 2

COMPARISON OF BANDWIDTH OF DIFFERENT TYPE OF CONFIGURATION

figures	Shape of patches	F_c, f_L f_H in GHz	Fractional bandwidth
	Triangular monopole UWB patch antenna Configuration A	f_L = 3.30 f_H = 5.54 f_C = 4.42	50.61% Wide Bandwidth
	Triangular monopole antenna with SRR on ground plane Configuration B	f_L = 3.98 f_H = 4.04 f_C = 4.21	1.42% Sharp-Narrow bandwidth OR Band pass filter
	Triple-bands configuration B	f_L = 5.13 f_H = 5.18 f_C = 5.15	1.08%
	Triple-bands configuration B	f_L =5.87 f_H =5.95 f_C = 5.91	1.35%

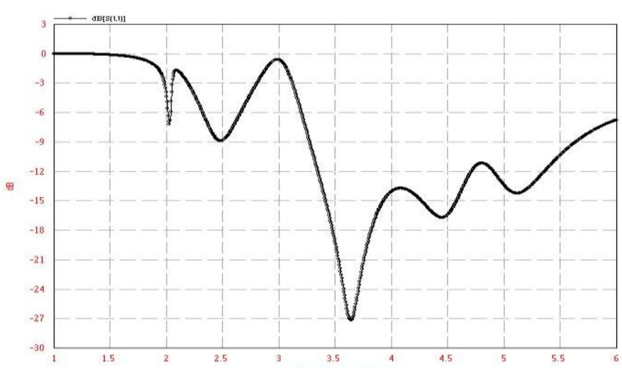


Fig.5: Return Loss Vs frequency for the Proposed Antenna A

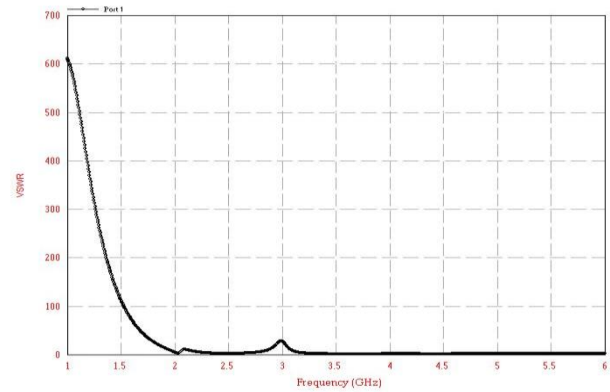


Fig. 6: VSWR of Proposed Antenna A

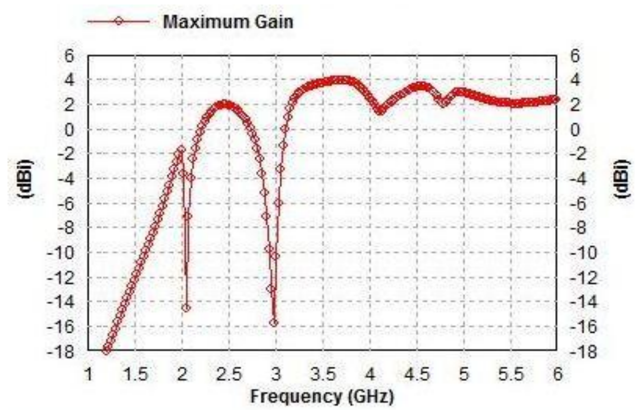


Fig.7: Gain Vs Frequency Proposed Antenna A

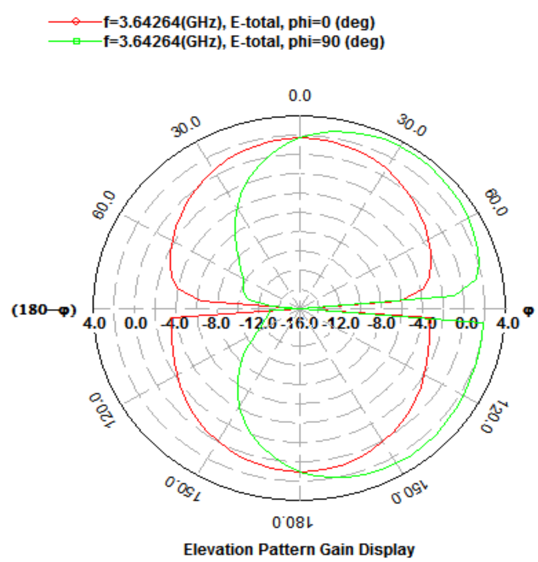


Fig.8: Radiation Pattern of Proposed Antenna A

In figure 5 minimum return Loss is 27.3dBi at resonance frequency 3.642GHz and fractional bandwidth is 50.61%. VSWR of proposed antenna A is 1.091 minimum at resonance frequency (3.642GHz) shown in figure 6. VSWR should be minimum for good input impedance matching. In figure 7 Maximum gain of proposed antenna A is 3.928 dBi at 3.71GHz. I calculate the radiation pattern at resonance frequency for ϕ=0 and ϕ=90 figure 8 shows that radiation is Omni-directional.

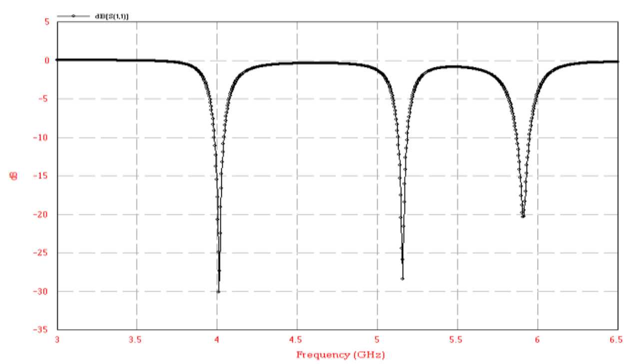


Fig.9: Return loss of Proposed Antenna B

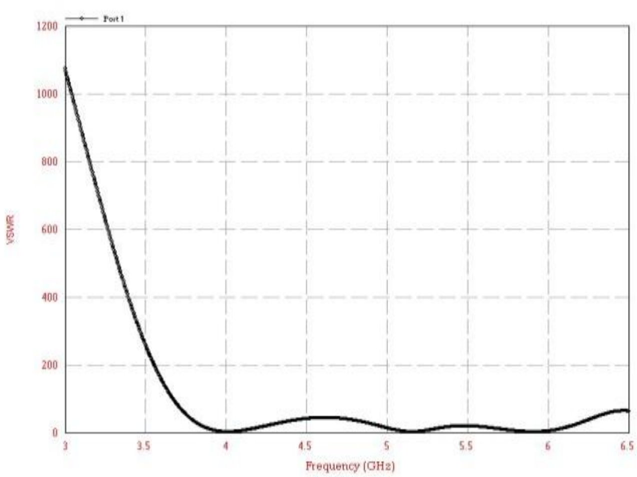


Fig.10: VSWR of Proposed Antenna B

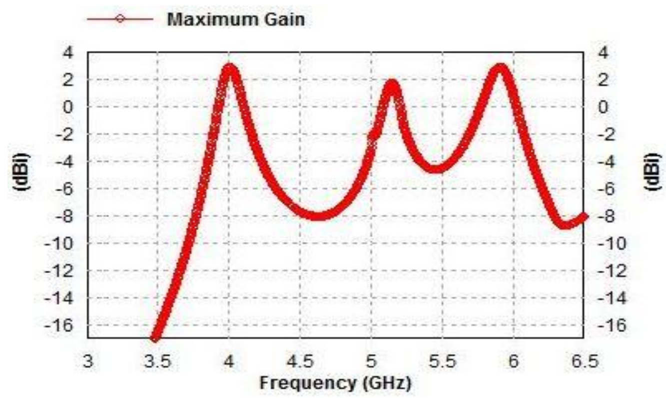
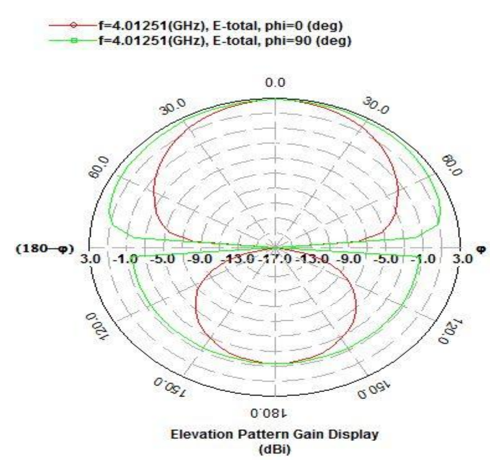


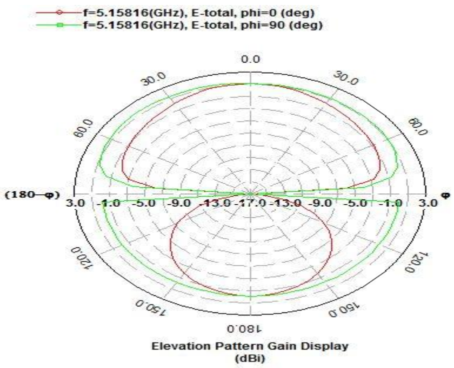
Fig.11: Gain Vs Frequency of Proposed Antenna B

In figure 9 proposed antenna B gives triple band at 4.01GHz, 5.15GHz and 5.91GHz with return losses -30.15dBi, -28.49dBi and -20.42dBi respectively. VSWR of proposed antenna B shown in figure10 at three different frequencies 4.013GHz, 5,15GHz and 5.91GHz are 1.09, 1.19, and 1.37 respectively. Gain of proposed antenna B at resonance frequencies 4.01GHz, 5.15GHz and 5.91GHz are 2.83dBi, 1.64dBi and 2.84dBi respectively. In direction of elevation 2D radiation pattern of proposed antenna B at three resonanse frquencies are given in figure 11.

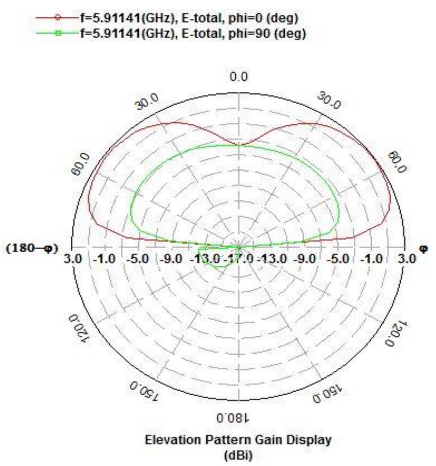
Radiation pattern of proposed antenna B shown in figure 12 at 4.01GHz is omnidirectional and it is calculated for ϕ=0 and ϕ=90 degee. It is also calculated at 5.15GHz and its radiation is bidirectional. At third resonance frequency(5.91GHz) radiation pattern is unidirectional.



(a)



(b)



(c)

Fig.12: Radiation Pattern of Proposed Antenna B

IV. CONCLUSION

A UWB Triangular Monopole Microstrip Patch Antenna has been successfully designed. It can be concluded from the above results that, designing a proper feed network and impedance matching are very important parameters in Microstrip In this triangular monopole Patch antenna design, we increases the bandwidth through triangular monopole structure cut on patch. Bandwidth of triangular monopole antenna is affected by variation in ground plane. It can be concluded from above result that split ring resonator play an important role in designing of triple band. It create strong magnetic coupling with applied electric field so it make band pass filter with resonance frequency of resonator and without SRR we can design wide band antenna. Different types of feed methods affect the performance of an antenna.

REFERENCES

[1] C.A. Balanis, "Antenna Theory, Analysis and Design" John Wiley & Sons, New York, 1997.

[2] J. Brown, "Artificial dielectrics" *Progress in Dielectrics, vol. 2, pp.195-225, 1960.*

[3] V. G. Veselago, "The electrodynamics of substances with simultaneously negative values of epsilon and mu" *Sov. Phys. Uspekhi, 10, pp. 509-514, 1968.*

[4] Y.T. Lo, Theory and experiment on microstrip antennas, *IEEE Trans. Antennas Propag. 27, pp. 137–145. 1979*

[5] K. Aydin and E. Ozbay, "Identifying magnetic response of split-ring resonators at microwave frequencies" Opto-Electron. *Rev, vol. 14, no.3, pp. 193-199, 2006.*

[6] Siddiqui, J.Y. Saha, c. Antar, Y.M.M., "A Novel Ultra wideband(UWB) Printed Antenna with Dual Complementary Characteristic" *IEEE Antennas and Wireless propag.Lett. Vol 14, PP. 974 - 977, 2014.*

[7] F. Ghanem, P.S. Hall and J.R. Kelly,"Two port frequency reconfigurable antenna for cognitive radio," *Electronics Letters, vol 45, no. 11, pp. 534-536, May 2009.*

[8] E. Ebrahimi, J.R. Kelly and P.S. Hall " Integrated wide-narrowband antenna for multi-standard radio" *IEEE Trans. Antennas propagat, vol. 59, no. 7, pp. 2628-2635, July 2011.*

[9] Y. Tawk and C.G. Christodoulou, "A new reconfigurable antenna design for cognitive radio" *IEEE Antennas and Wireless propag.Lett., vol. 8, pp. 1378-1381, 2009.*

[10] J. Liang, L.Guo, C.C. Chiau, X. Chen and C.G. Parini, "Study of CPW-fed circular disc monopole antenna for ultra wideband applications",*IEEE Proc. Microw. Antennas Propagat., vol. 152,no. 6, pp. 520-526, Dec. 2005*.

[11] C. Mahatthanajatuphat, P. Akkaraekthalin, "A Double Square Loop Antenna with Modified Minkowski Fractal Geometry for Multiband Operation," IEICE Transactions on Communications, *Vol. E90-B, No. 9, 2007, pp. 2256–2262.*