ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 2 , February 2017

Gain and Bandwidth of Micro-strip Patch Antenna with Split Ring Resonator (SRR)

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ABSTRACT: This paper present the improvement in gain of micro-strip patch antenna, which is used with Circular, Rectangular and Square shaped split ring resonator designed at a separate substrate at height 0.05mm from the ground plane. In spite of design complexity it is easy and commercially cheap way of enhancing gains of micro-strip antenna. Simulations have been performed using High Frequency Structure Simulation Software (HFSS).

KEYWORDS: CSRR, SSRR & RSRR Bandwidth, S-parameters, VSWR, Gain using HFSS Software.

I. INTRODUCTION

Now a day, WLAN or Wireless Local Area Network has become more popular. For example, the portable devices like laptop, notebook, PDA, and mobile phone are incorporated with WiFi and Bluetooth technologies to connect. Since 1999, researchers have proposed many structure designs to form metamaterials structure.
Metamaterials are the artificial materials. They have some unusual properties like negative permittivity and permeability which natural materials do not have [3]. Split ring resonators and thin wires have been the metamaterial components to achieve negative permittivity and negative permeability, respectively [4]. Improvement in antenna bandwidth gain can be achieved using metamaterials. Researchers have been working on metamaterial-based antenna designs for improvement in gain and bandwidth [5]. One of the ways to improve the bandwidth and gain is metamaterial superstrate loading in antennas. Metamaterial inspired superstrate has been used to increase gain micro strip patch antenna [6]. High directive antenna has been designed with metamaterial superstrate for Ku band. Metamaterial superstrate has been made up
Of two metallic grids and foam slices. A high gain wideband antenna has been designed with single layer metamaterial superstrate. The metamaterial is designed to have zero refractive index to enhance the gain of the antenna [7]. Tunable metamaterial superstrate has been used in antenna for beam steering applications. Directivity and bandwidth of the micro strip antenna has been enhanced using metamaterial superstrate.

II. MULTIPLE SPLIT RING RESONATOR DESIGN

The split ring resonator can be applied in many designs such as antennas [8], microwave absorber [9], filters [10], frequency selective surface [11] and others. There are many me dimensions of split ring resonator that have been designed by a few researchers. In this SRR design, there are multiple metallic split rings, printed on a microwaves dielectric circuit board. The gap between the split rings, and size of the split ring resonator. This paper focuses on the effect of different types of split ring resonator shapes. Figure represents two types of multiple split ring resonator shapes that used in the simulation. The shapes are rectangular and square. All shapes have the same dimensions of gap between split ring and also the width of ring for parameter control.
The resonance frequency of SRR is given by f = (LCs) −1/2/2π, where Cs is the series capacitance of the upper and lower halves of the SRR, i.e. Cs = C/4. The equivalent circuit analysis can be extended to multiple SRRs shown in Figure 1. The series capacitance Cs of the split ring resonator with three rings can be calculated from the mutual capacitance between the rings C12 and C23, and it is equal Cs = (C12 + C23)/4. The series capacitance Cs of the split ring resonator with four rings can be calculated from the mutual capacitance between the rings C_{12} C_{23} andC_{34} it is equal to:
$C_S = (C_{12} + C_{23} + C_{34})/4$

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International Journal of Advanced Research in Science, Engineering and Technology

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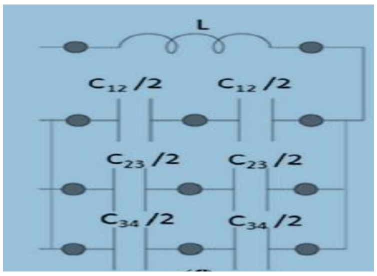


Fig1: Equivalent electric circuit of split ring resonator shown respectively. L is the equivalent inductance of the ring.

III. DESIGN AND SIMULATION

In this paper we design patch antenna with circular, Rectangular and Square split ring resonator and it is compared without slot MPA on the ground plane using HFSS13. The construction of new type structure with split ring is very difficult task with desired LHM properties. In the light of various ring type known structure such as U shaped, S shaped, triangular split resonator, we decides to build a new LHM using circular split ring resonator geometry with various rings.

This simple without slot MPA design and it is compared with circular, Rectangular and Square split ring structure is designed and simulated on HFSS software in terms of S-parameters [12] leading to effective EM parameters.

A. Basic Rectangular Patch Antenna

The rectangular patch antenna is shown in figure 1.The length and width of the antenna is 17mm and 17mm respectively. The printed antenna is etched on ground substrate. A micro strip patch antenna is designed for the resonant frequency 9.39GHz. Simple rectangular patch antenna is fed by micro strip feed technique is shown in figure 2.

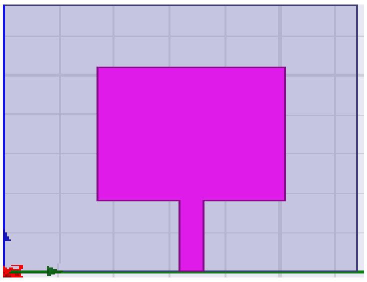
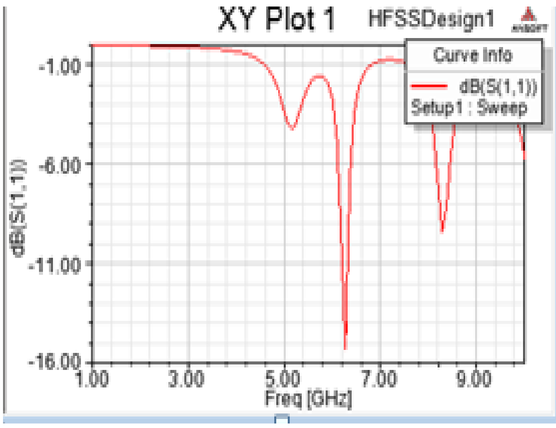
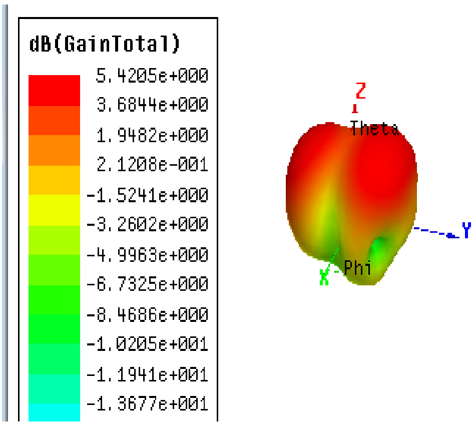


Fig 2: without slot Shape antenna



(a)



(b)

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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B. Designing of Circular Split Ring Resonator using HFSS

The design parameters of circular SRR are following:
R(Radius) $=r_1 7.5, r_2 6\ , r_3 4.5, r_4,3$
S (separation between the ring) = 1 mm
N (number of rings) = 4
Ground position = (0×0×-0.794)mm
In designing, the substrate is rogers RT/duroid 5880(tm). The relative permittivity and permeability of rogers RT/duroid 5880(tm) are 0.05 respectively and its loss tangent is 0.0027. The Square split ring resonator (HSRR) is shown in figure 2.

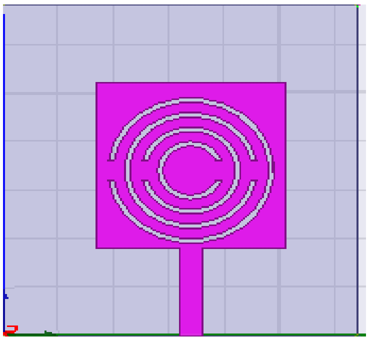
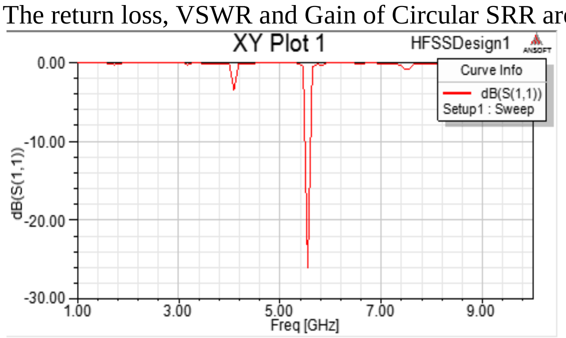
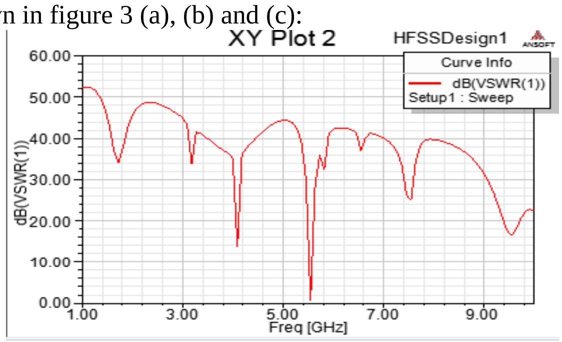


Fig3: Design of Circular SRR

The return loss, VSWR and Gain of Circular SRR are shown in figure 3 (a), (b) and (c):



(a)



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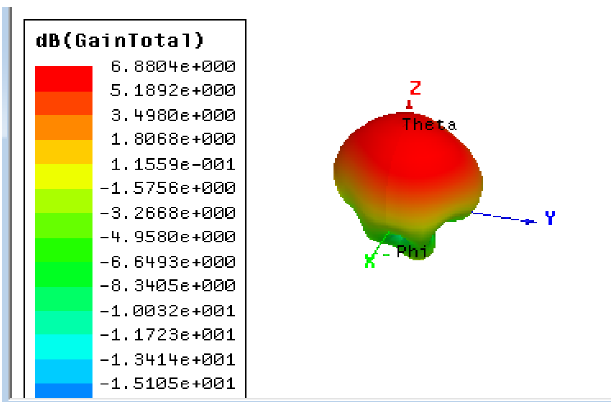

(c)

The resonant frequency of Circular Split Ring Resonator is 9.39 GHz, return loss is -26dB and Gain is 6.8 dB.

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International Journal of Advanced Research in Science, Engineering and Technology
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C. Designing of Square Split Ring Resonator using HFSS

The design parameters of Square SRR are following:
L (length of the side) = 3 mm
W (width of the split ring) = 1 mm
S (separation between the ring) = 1 mm
N (number of rings) = 4
Ground plane position = (0×0×-0.794)mm

In designing, the substrate is rogers RT/duroid 5880(tm). The relative permittivity and permeability of rogers RT/duroid 5880(tm) are 0.05 respectively and its loss tangent is 0.0027. The Square split ring resonator (HSRR) is shown in figure 3.

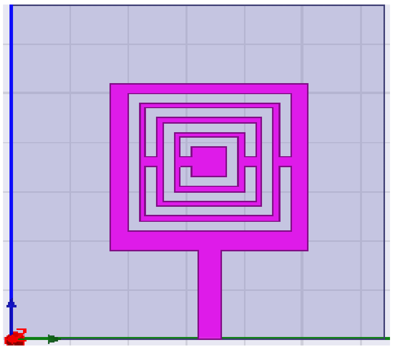
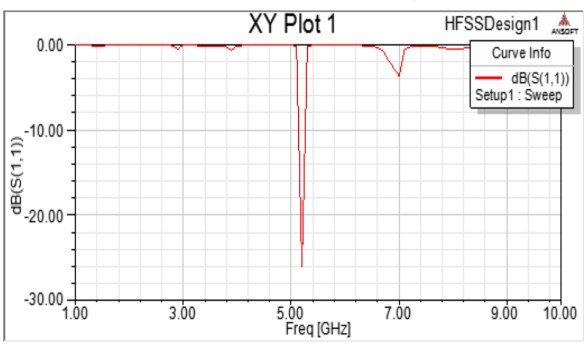
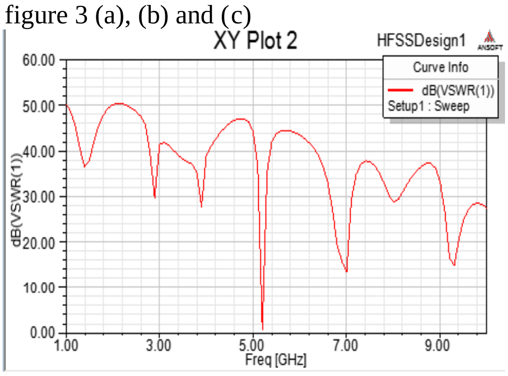


Fig4: Design of Square SRR

The return loss, VSWR and Gain of Square SRR are shown in figure 3 (a), (b) and (c)



(a)



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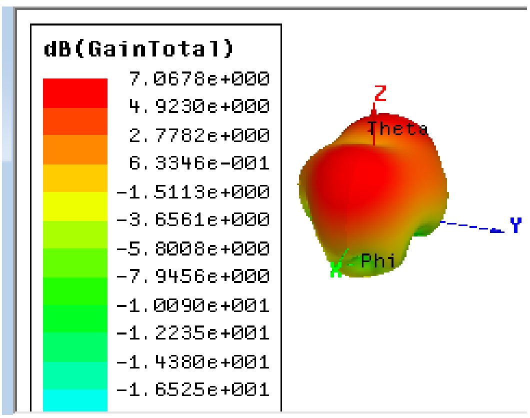

(c)

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International Journal of Advanced Research in Science, Engineering and Technology
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The resonant frequency of Square Split Ring Resonator is 9.39 GHz, return loss is -26dB and Gain is 7.0dB.

D. Designing of Rectangular Split Ring Resonator using HFSS

The design parameters of Rectangular SRR are following:
L (length of the side) = 3.5 mm
W (width of the side) = 3.5 mm
S (separation between the ring) = 1.5 mm
N (number of rings) = 4
Ground position = (0×0×-0.794) mm

In designing, the substrate is rogers RT/duroid 5880(tm). The relative permittivity and permeability of rogers RT/duroid 5880(tm) are 1.2 respectively and its loss tangent is 0.0027. The Square split ring resonator (HSRR) is shown in figure 4.

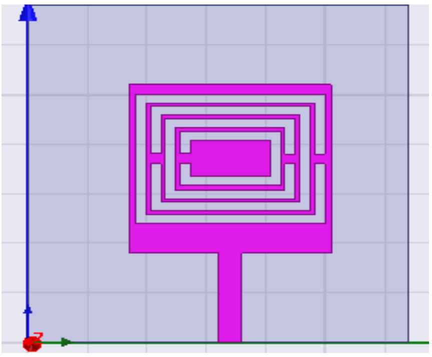
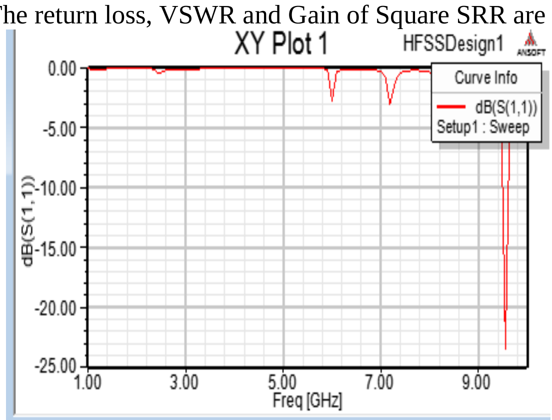
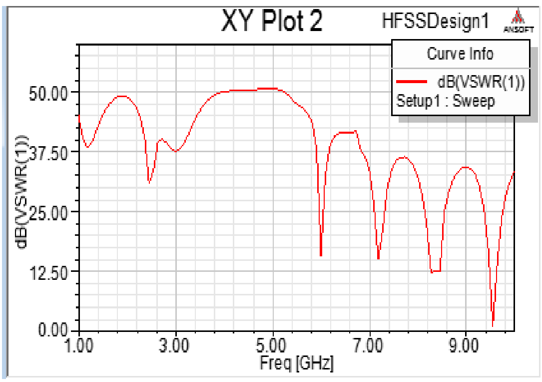


Fig5: Design of Rectangular SRR

The return loss, VSWR and Gain of Square SRR are shown in figure 4(a), (b) and (c):



(a)



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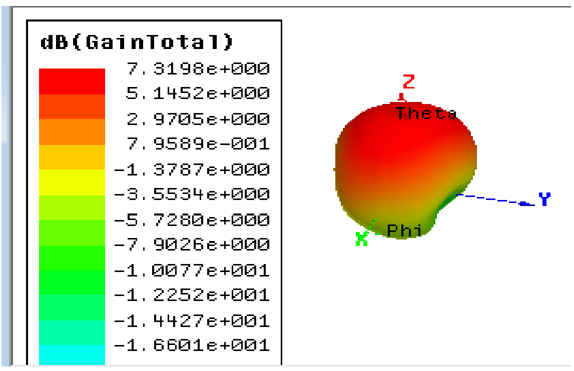

(c)

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International Journal of Advanced Research in Science, Engineering and Technology
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The resonant frequency of Square Split Ring Resonator is 9.39 GHz, return loss is -25dB and Gain is 7.3dB.

IV. PERFORMANCE PARAMETERS OF MICRO STRIP PATCH ANTENNAS WITH SRR TECHNIQUE

The design parameters of these structures are same but the circular shape SRR is differing and the results are also different. The comparison between without slot MPA with Square Split Ring Resonator, Rectangular Split Ring Resonator and Circular Split Ring Resonator are shown as following table 1.
Table 1: Comparisons b/w CSRR, SSRR & RSRR

S.No	Without slot / Shape of Structure	Return Loss	Gain	VSWR	BW
1	Without slot	-16dB	5.4dB	5.1	0.1
2	CSRR	-26dB	6.8dB	1.7	0.13
‘’’3	SSRR	-28dB	7.0dB	1.4	0.13
4	RSRR	-25dB	7.3dB	1.1	0.13

V. CONCLUSION

In summary, we have shown numerically computed results using FEM based Ansoft HFSS for CSRR,SSRR & RSRR showing negative magnetic permeability for specific frequency region [13]. This artificial MNG material has got widespread application for improvement of radiation property of antenna [14] .These SRR structures use same roger substrate having same dielectric loss tangent of 0.02 and permittivity 0.05. Absorbance data computed from numerically simulated scattering parameter suggests that with increasing substrate thickness absorption loss associated with SRR gradually increases for both RSRR and CSRR for same substrate permittivity and dielectric loss tangent

REFERENCES

[1] Bahl and P. Bhartia, “Microstrip Antennas”, Dedham, Ma, Artech house, 1981.
[2] Yoonjae Lee, Simon Tse, Yang Hao and Clive G. Parini “A Compact Microstrip Antenna with Improved Bandwidth Using Multiple Split-Ring Resonator Loading”, IEEE, pp. 5431-5434, 2007.
[3] V eselago VG. the electrodynamics of substances with simultaneously negative values of ε and μ. Soviet Phys. Usp. 1968;10:509–514.
[4] Smith DR, Padilla WJ, Vier DC, et al. Composite medium with simultaneously negative permeability and permittivity. Phys. Rev. Lett. 2000;84:4184–4187.
[5] Patel SK, Kosta Y. Triband microstrip-based radiating structure design using split ring resonator and complementary split ring resonator. Microwave Opt. Technol. Lett. 2013;55:2219–2222.
[6] L i D, Szabo Z, Qing X, et al. A high gain antenna with an optimized metamaterial inspired superstrate. IEEE Trans. Antennas Propag. 2012;60:6018–6023.
[7] Ju J, Kim D, Lee WJ, et al. Wideband high-gain antenna using metamaterial superstrate with the zero refractive index. Microwave Opt. Technol. Lett. 2009;51:1973–1976.
[8] A. A .M. Ezanuddin F. Malek, P.J. Soh, “investigation of multiple split ring resonator with dielectric ring,” 2010 Loughborough antennas and propagation conference (LAPC), pp. 297-300, 2010.
[9] H. Nornikman, F. Malek, P.J. Soh A.A.H. Azremi,”design a rice husk pyramidal microwave Absorbed with split ringbresonator, the asia- pacific symposium on applied electromagnetic and mechanics 2010.
[10] D.J. Kern, D.H. Werner, A. Monorchio, L. Lanuzza, M.J. Willhelm,” the design synthesis of multiband artificial magnetic conductor using high impedence frequency selective surfaces, “ IEEE Transaction on antenna and propagation, vol.53, issue 1, part 1,pp.8-17, 2005.
[11] J.B. Pendry,A.J.Holden , D.J. Robbins,W.J. Stewart, “magnetism from conductors and enhanced nonlinear phenomena, “ IEEE trans. Microwaves theory tech, vol47, pp.2075-2084,1999.
[12] Alici, K.B. and E. Ozbay, “Characterization and tilted response of a fishnet metamaterial operating at 100 GHz,”J.Phys.D:Appl.Phys.,Vol.41,13501,2008.
[13] Gil, N., J. Bonache, J. Selga, J. Garcia – Garcia, and F. Nartin, “High pass’ filters implemented by composite right/left handed (CRLH) transmission lines based on complementary split rings resonators (CSRRs),” PIERS Online, Vol.3, No.3, 251-253, 2007.
[14] Jiafu Wang,Shaobo Qu,Zhuo Xu,Jieqiu Zhang,Hua Ma,Yiming Yang, Chao Gu,“ Broadband planar left-handed metamaterials using split-ring resonator pairs” Photonics and Nanostructures-Fundamentals and Applications, vol. 7,pp-108-113,2009.