Resonator based Broadband Planar Antennas on Left Handed Metamaterials

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Abstract—*A study of single-ring resonators and double-ring resonators is presented in the form of equivalent circuits. Simple LC circuits intrinsically give fine details for resonant particles even if their resonant behaviours are rooted by conceptually distinct phenomena, either distributed or quasi-static resonances can be attributed for designs with similar geometrical dimensions. When placed on the back-plane of a coplanar waveguide, and merging with short-circuiting wires on the top-plane, the periodic structures designed so far shows a certain pass-band where backward waves are generated. The left-handed behaviour can be observed for both types of resonators and is proved through the analysis of the phase of different length transmission lines*

Keywords— **Resonators, Metamaterials, IE3D, Patch Antenna, Transmission lines**

1. INTRODUCTION

A single-ring resonator also behaves as a magnetic resonator. Single ring resonator (SRRs), originally proposed by *Pendry et al.* , have attracted great interest among microwave engineering due to their potential applications to the synthesis of artificial materials (meta-materials). It has also been demonstrated that many other resonator topologies, derived from the basic SRR proposed by *Pendry et al.*, are appropriate to achieve effective (continuous) media with negative permeability[1].

In double-ring resonator compared to the single ring resonator, is that the magnetic resonance frequency of the double ring occurs at a relatively lower frequency. This leads to a higher probability for the magnetic response to lie in the $\varepsilon < 0$ regime when combined with strip wires in the metamaterial structure.

2. DEFINITION OF SINGLE AND DOUBLE RING RESONATOR

There has been a growing interest in using the split-ring resonator (SRR) and double ring resonator (DRR) as constituent particles for the design of novel planar microwave components, in particular band-reject filters. The benefit of using this type of resonator for filter design is that they are remarkably smaller in size than standard resonator structures (generally less than one-tenth of a wavelength) enabling the design of very small size filters.

It has been shown that when loaded with Single Ring Resonators, microstrip lines behave as high-Q, band-reject filters with deep stop-bands in the region of their resonant frequencies due to the generation of an effective medium with negative permeability.

A microstrip transmission line produces magnetic field lines that close upon themselves around the line. If two arrays of SRRs are positioned closely at both sides of the central line, a major portion of the magnetic field lines induced by the line is expected to cross the Single Ring Resonators with the desired polarization giving rise to a negative-μ effect over a narrow band around the resonant frequency of the individual SRRs[1]. Hence, inhibition of signal Propagation over this band can be achieved.

3. CIRCUIT MODEL

By means of Metamaterials[2] it is possible to achieve single and double SRR based on open c ring using patch here SRR possesses stronger magnetic response which might lead to a more robust left handed peak for the metamaterial structure. The proposed SRR based antenna physically implemented on top substrate having dielectric constant (ε_r) is 4.4 with the substrate thickness 1.6 mm and having Loss tangent of 0.02 using conventional fabrication process.

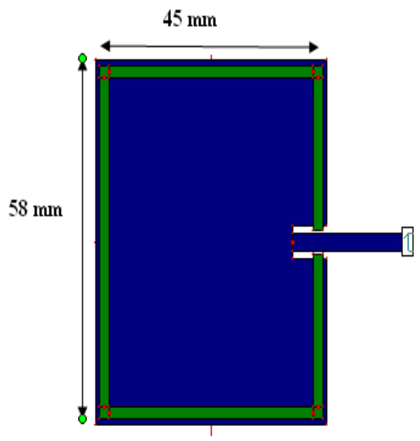

Fig-1: Dimensions of Single Ring Resonator Antenna (Top Layer)

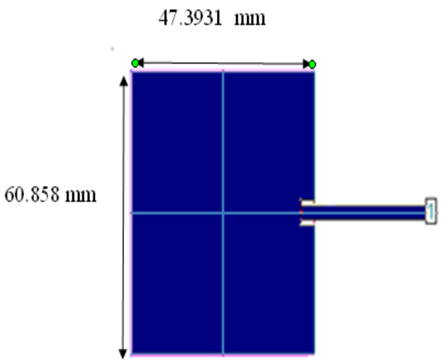

Fig-2: Dimensions of Patch Antenna (Top Layer)

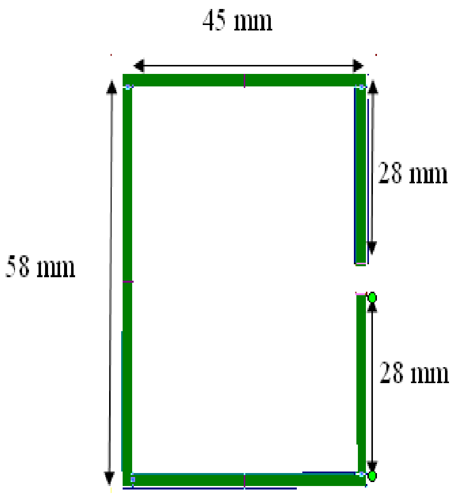

Fig-3: Dimensions Of Cut Single C Ring (Ground Layer)

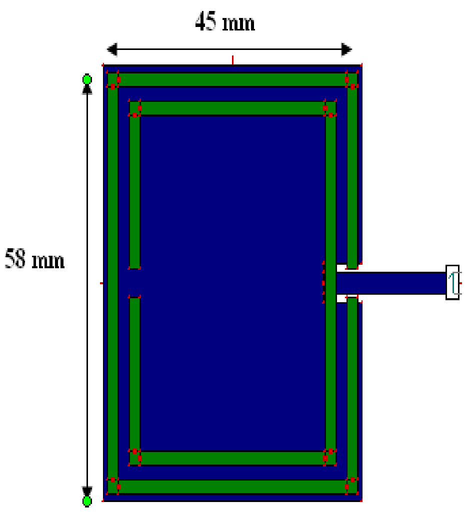

Fig-4: Dimension of Double Ring Resonator Antenna (Top Layer)

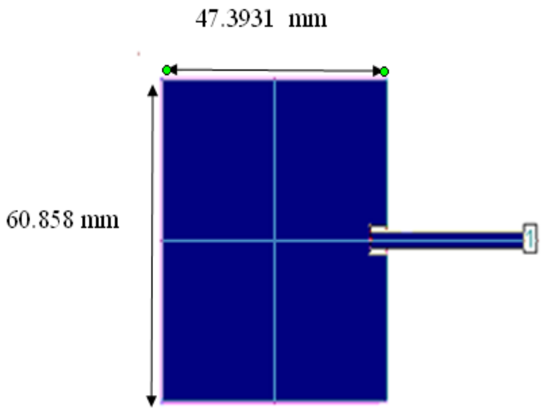

Fig-5: Dimension of One Patch Antenna (Top Layer)

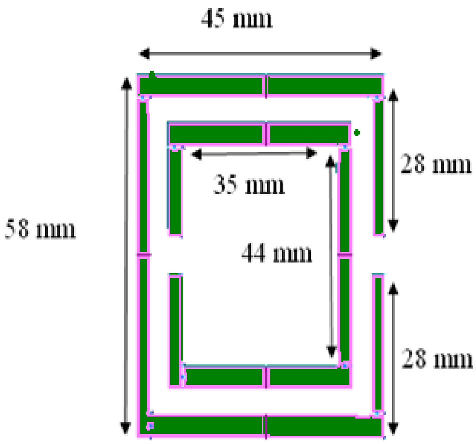

Fig-6: Dimension of Cut Double C ring (Ground Layer)

Fig- 7: Photograph of Finally Fabricated Micros trip Patch Antenna (Top Layer).

Fig- 8: PhotographOf Finally Fabricated Microstrip Patch Antenna Using Single C Ring (Ground Layer).

Fig-9: Photograph of Finally Fabricated Microstrip Patch Antenna Using Double C Ring (Top Layer**).**

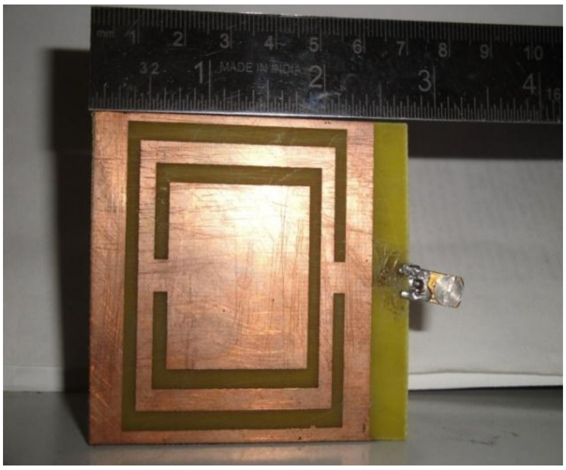

Fig-10: Photograph of Finally Fabricated Microstrip Patch Antenna using Double C Ring (Ground Layer**).**

Scattering parameters are measured using a spectrum analyzer. Numerical calculations of the scattering parameters are performed using the Method of Moments (Mom) based electromagnetic solver IE3Dcommercial software [3][4][5]. Measured and simulated return losses are presented in Figure 3.8 (a), (b) which exhibits a good agreement. The center frequency of the Antenna is 1.5 GHz. Some small variations between the measured and simulated return loss values can be attributed to some impedance mismatches as a result coax-to-microstrip transitions at both connector sides and also imperfections in fabrication process[6][7][8].

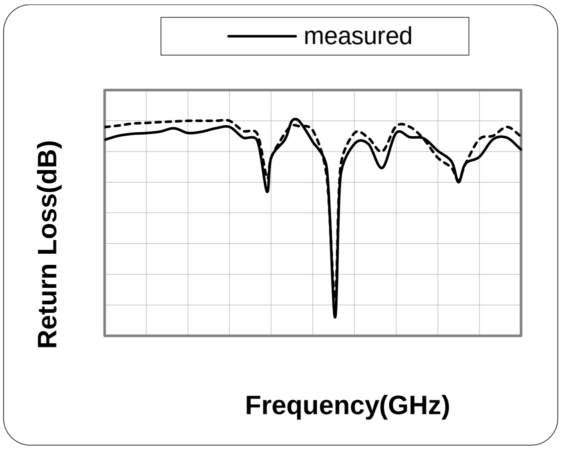

Fig- 11: Variation of Reflection Coefficient with Frequency of Single C Ring Antenna.

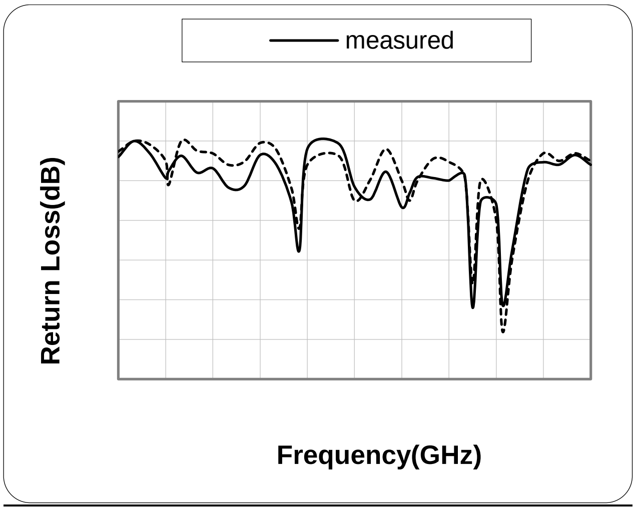

Fig- 12: Variation of Reflection Coefficient with Frequency of Double C Ring Antenna

4. CONCLUSION

This work examined three techniques to localize and demonstrate the LH behavior of ametamaterial. At the same frequencies, a negative index of refraction was demonstrated by calculating the direction of power leaving a metamaterial prism. Thetwo methods of calculating the index of refraction of the

Metamaterialsgave consistent results in different SRR geometries. The phenomena that leads to LH behavior in metamaterials and can be easily changed to examine new metamaterial geometries in the future.

5. REFERENCES

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