Asymmetric Single Split Resonator for RFID Applications

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Outline

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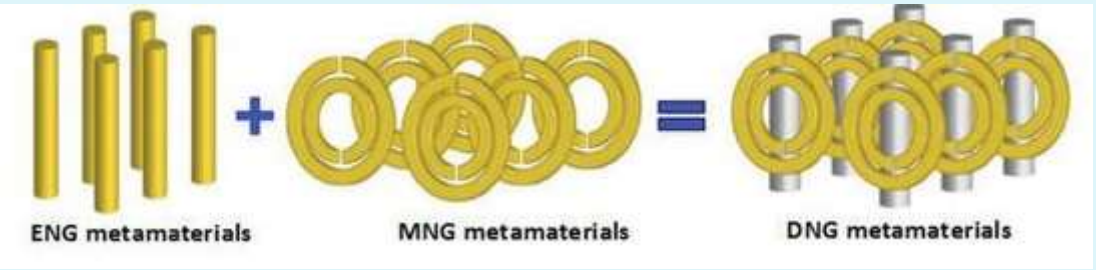
1. Introduction

- Metamaterial:-



- Applications of metamaterials include antenna miniaturization,bandwidth enhancement, directivity/gain enhancement, spurious radiation suppression, superdirectivity etc
- SRR is having a symmetric geometry which will reduce the nonlinear behavior

1. Introduction

- For filter and RFID applications, it needs more energy density which can be attained by increasing the nonlinear behaviour
- Fedotov et al [8] proposed that the resonator obtained by crossing the symmetry leads to extremely sharp resonance and concentrating local fields in a small volume supporting trapped modes.

2. Asymmetric Single Split Resonator (ASSR)

- Geometry is by offsetting the inner ring of double ring SRR on to one side
- A unit cell of 30 mm x 30 mm dimension is simulated for infinite periodic arrangement of ASSR

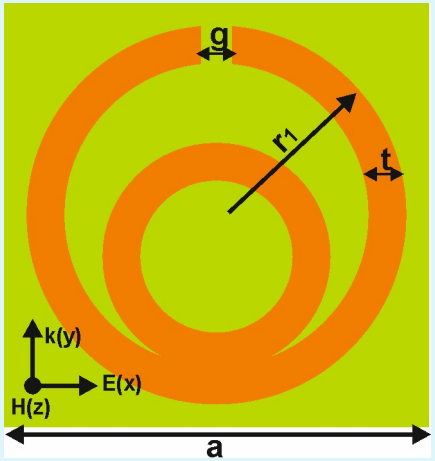


Figure 1. **(a)** Structure of a unit cell with its dimensions and field vectors (r_1=12 mm, g=2 mm, t=2 mm, outer radius of the inner ring is 7 mm and center to center distance= 3.15 mm, a=30 mm) in FR4 substrate **(b)** Fabricated unit cell on FR4 substrate

3.Methodology

- Infinite periodic arrangement and unit cell simulation by CST Microwave Studio
- Experimental analysis by PNA E8362 vector network analyzer
- Based on transmission and reflection coefficients using microstrip fixture method[9]

4. Results and Discussion

A uniform plane wave is made incident for parallel polarization that is propagation along Y axis where electric field and magnetic fields are oriented along X and Z axes respectively

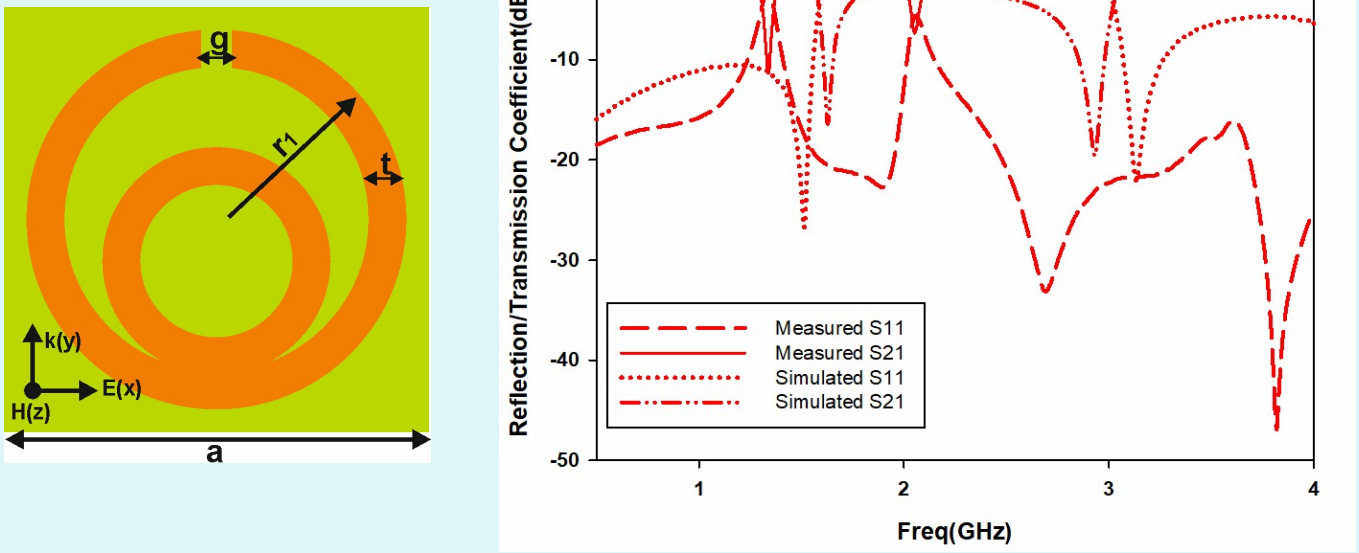


Figure 2. **(a)** Unit cell filed orientations for simulation **(b)** simulated and measured reflection and transmission coefficients of ASSR

4. Results and Discussion

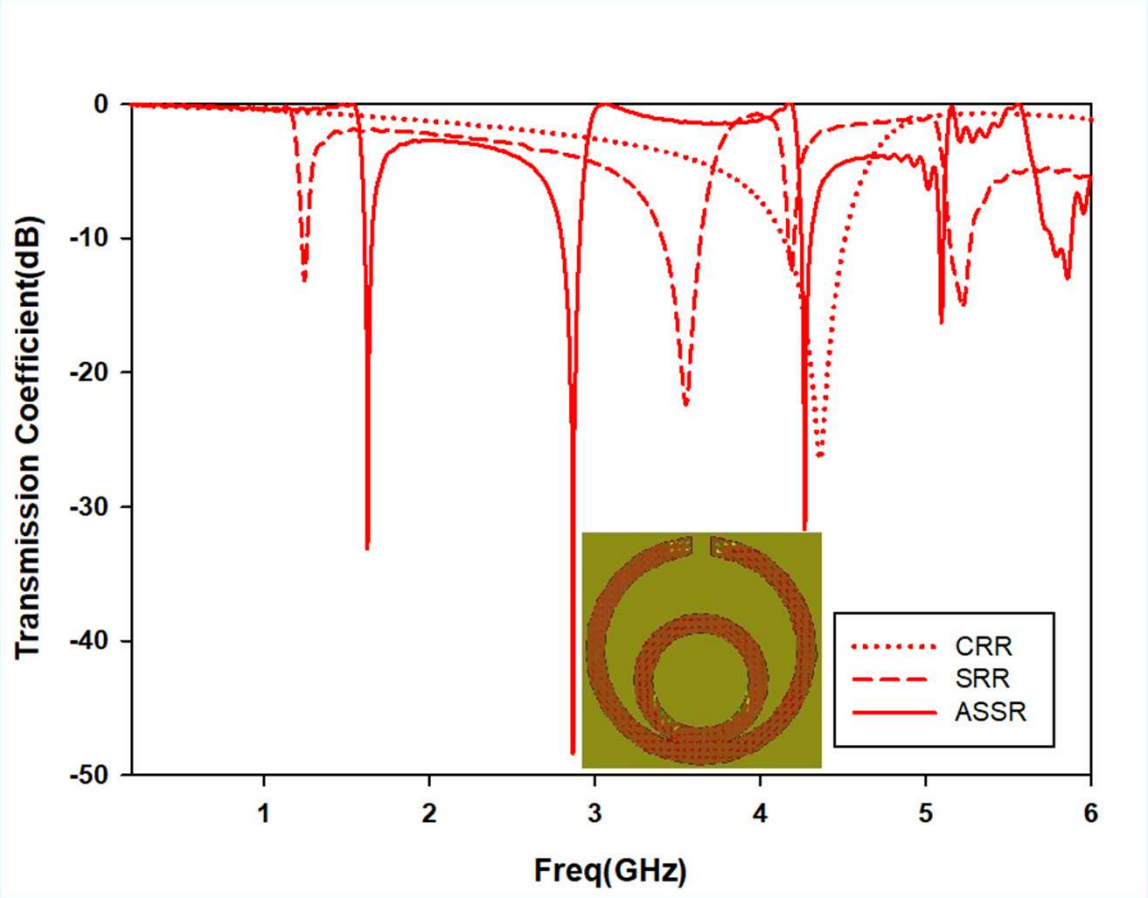


Figure 3. Simulated transmission coefficients of (a)CRR (b)SRR (c)ASSR

4. Results and Discussion

- Magnetic resonance of the structure is identified by comparing it with a closed ring resonator (CRR) of same dimensions
- The fundamental resonance of CRR is found to be at 4.365GHz whereas the ASSR shows the first resonance which is the magnetic resonance of the resonator at 1.63GHz
- But an SRR of same outer diameter and gap width and excited with same boundary conditions exhibits a lower resonance of 1.23GHz since the capacitance effect in SRR is more as compared to an ASSR

4. Results and Discussion

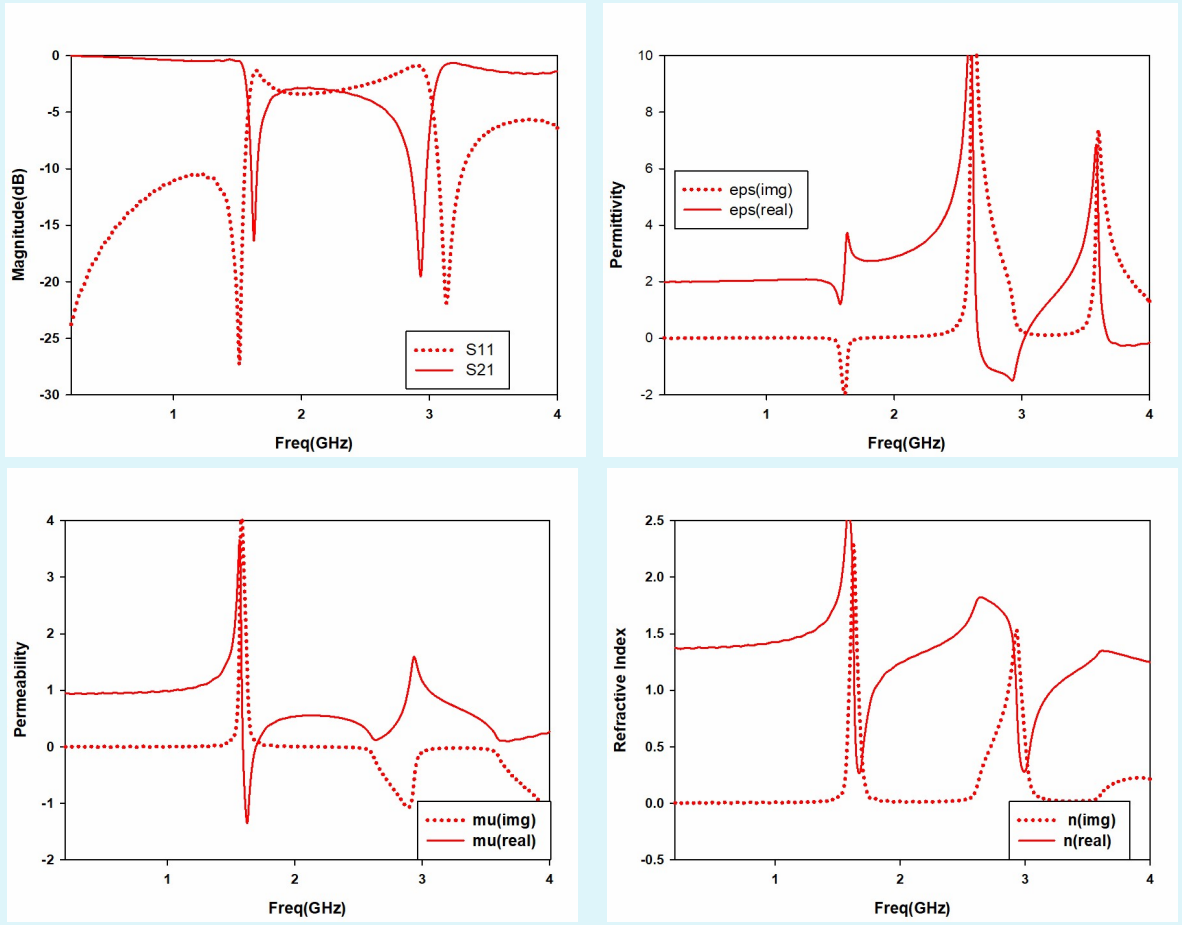


Figure 4. (a) Transmission and reflection coefficients (b) Permittivity (c) Permeability (d) Refractive Index

4. Results and Discussion

- The anti-parallel loop currents through the inner and outer rings indicate the existence of negative permeability also evident from Figure 4(c)
- The second resonance of ASSR is showing negative permittivity as seen in Figure4(b)
- Both resonances are brought closer by introducing asymmetry

4. Results and Discussion

- The electric field is dominant at the vicinity of splits/gap between the rings
- It seems to be three times as that of SRR

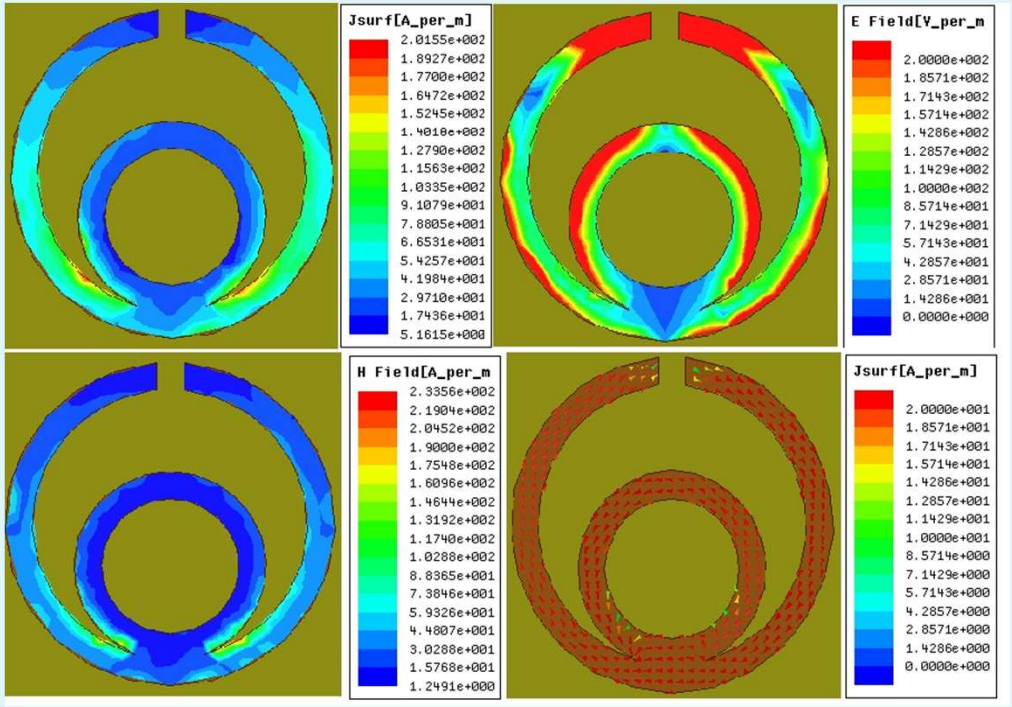


Figure 5. Magnitudes of Current, Electric field, Magnetic field and Current distribution with its phase

4. Results and Discussion

- The asymmetric distribution of current increases the energy density within the volume.
- Hence the field confinement is more for ASSR as compared to an SRR of same dimension.
- Thus, it may be well suited for filter and RFID applications rather than SRR.

5. Conclusions

- A new metamaterial to achieve the negative permeability is proposed in this paper
- The ASSR structure is a modified form of basic split ring resonator and is asymmetric
- It exhibits high field confinement as compared to SRR, so it can be used for filter and RFID applications
- The paper presents the constitutive parameters of ASSR for parallel polarization with supporting simulation and measurement results
- It can be used for single negative and/or double negative metamaterial applications with different polarization of incident wave

6. References

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Thank you