FILTER BASED ON SPLIT RING RESONATOR

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ABSTRACT

This paper presents a novel wideband bandpass filter making use of split ring resonator (SRR) as the basic ring resonant unit. The resonant characteristic of SRR is carefully studied through full wave analysis. The coupling of SRR structure is very effective that can be used to realize wideband filter with small insertion loss. A filter with center frequency at 2.4GHz, passband 1.8GHz to 3.4GHz is designed using FR4 dielectric substrate with 1.6mm thickness. The simulated results are good consistent.

Keywords: *Complementary square split ring resonator (SRR), Band pass, Dielectric Substrate.*

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1. INTRODUCTION

At current time the user are demand on the high data rate and mobility technology of telecommunication devices with the smaller antenna design and multi frequency capability. Beside the telecommunication area, the others critical areas that also require this enhanced technology are in automotive, oil and gas, biomedical, military, and also in agriculture sector. One of the techniques that apply to reduce the size of antenna and multi frequency for multi-application is using split ring resonator (SRR) structure. These split ring resonators structures have purposes to enhance the return loss and bandwidth performance of microstrip patch antenna. Beside antenna technology, this technique also can have been applied in many telecommunication area applications, such as microwave filter, frequency selective surface (FSS), microwave absorber, oscillator, amplifier, switch and many others.

The attractive features of the microstrip ring resonator are its compact size, low cost, high Q and low radiation loss. In applications the ring resonator has been used to design filters, mixers, oscillators and antennas [1]. Recently, the novel double slot ring resonators, named complementary split ring resonators, named complementary split ring resonators (CSRR), were developed for band pass filter [2-11], band reject filter [12], low pass filter [13] and high pass filter [14] applications. Basically, these filters based on CSRR structure and alternative couplings were used to design the desired filter for applications. [1-14]. Recently, there has been a growing interest in using the split-ring resonator (SRR) and the complementary split ring resonator as constituent particles for the design of novel planar microwave components, in particular, band-pass and band reject filters. The advantage of using this kind of resonators for filter design is that they are significantly smaller in size than conventional resonators structures (generally less than one-tenth of a wavelength) enabling the design of very compact filters. Similarly, a CSRR-loaded microstrip line, which can be considered as the dual of the SRR-loaded line, inhibits signal propagation over a narrow band around the resonant frequency of the CSRR.

2. SPLIT RING RESONATOR

The split ring resonator is a popular artificial magnetic material or mate material structure. The most exciting feature of this split ring resonator structure is its capability to exhibit a quasi-static resonant frequency at wavelengths that are larger than its own size. Thus split ring resonator structure has the potential in to reduce the size of microwave range application design.

Dual mesh-shaped coupling applied in configuration of CSRR, designated as CSRR-based BPF, are constructed. First, the novel dual mesh-shaped coupling is used to present the coupling way in wide pass band applications. To obtain a good performance with stop-band improved CSRR. Two very simple band-reject filter topologies, one for the SRR and the other for the CSRR, with exactly the same SRR and CSRR dimensions are chosen so that a fair comparison of their stop band characteristics can be performed. Both topologies offer very compact band reject filters. However, some important stop band characteristics of SRR based counterparts. Simulation result including surface frequency response and return loss are presented and discussed.

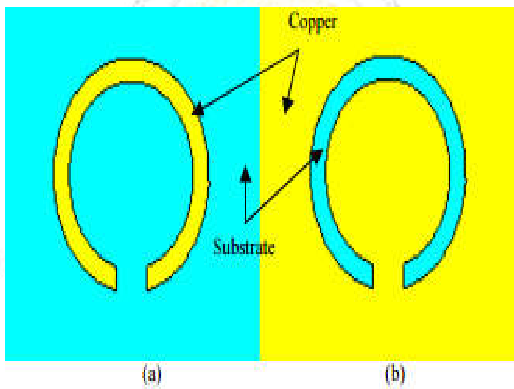

Figure 1 Normal edge couple split ring resonator, (b) Complementary edge couple split ring resonator

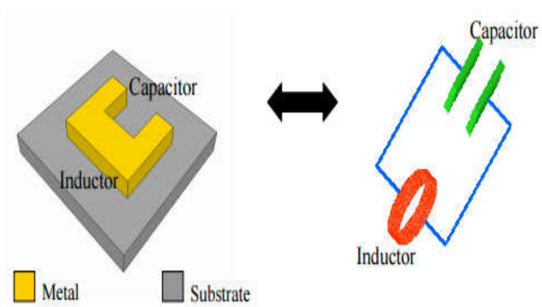

Figure 2 Split Ring Resonator and Equivalent Circuit

3. ANTENNA DESIGN

The split ring resonator (SRR), or dual split ring resonator (DSRR) as it is called, of a planar metallic structure is obtained by replacing the metal parts of the original structure with apertures, and the apertures with metal plates. These apertures have the exact dimensions as the corresponding split ring resonator (SRR). As shown in Fig.2, the original split ring resonator is the dual of its complementary one. The geometrical parameters of the SRR unit cell, shown in Fig.1(b), have been optimized to obtained a resonance frequency at 2.4GHz. The substrate type is FR-4 material with a thickness of 1.6mm, dielectric loss tangent=0.01, and relative permittivity(ε_r) = 4.4. The coated copper thickness and conductivity are 17μm. The optimized parameters of the SRR unit cell are: a=7mm, b=3mm, e=0.8mm, g=1mm.

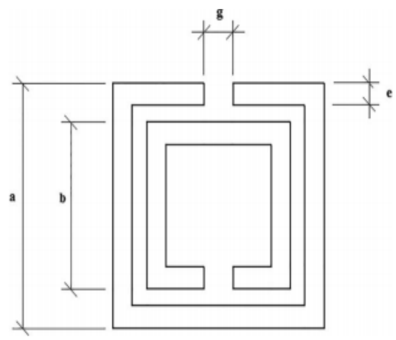

Figure 3.Dimensions of Physical geometries of split ring resonator

Figure 4. Split ring resonator in series feed

Figure 5. Split ring resonator in corporate feed

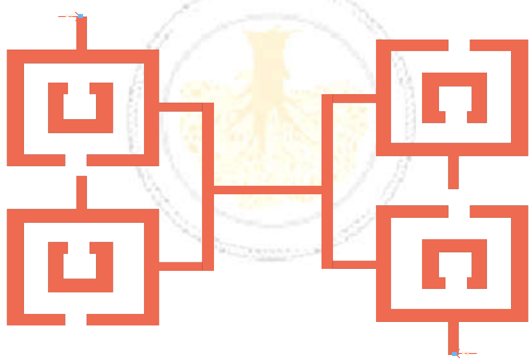

Figure 6. Split ring resonator in parallel feed

There are many split ring resonator parameters that affect the performance of the microstrip patch antenna design. The example parameters are the split ring resonator shape, the gap between the split ring, the width of the rings, the number of split rings, and the size of the split ring resonator. The paper focuses on effect of different feed of split ring resonator shapes that used in the simulation. All the feed have the same dimension of the gap between split ring and also the width of the ring for parameter control

4. RESULTS AND ANALYSIS

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The parameters which are analyzed include the effect of the split ring resonator structure on patch antenna design, different feed between SRR, but the dimensions are same.

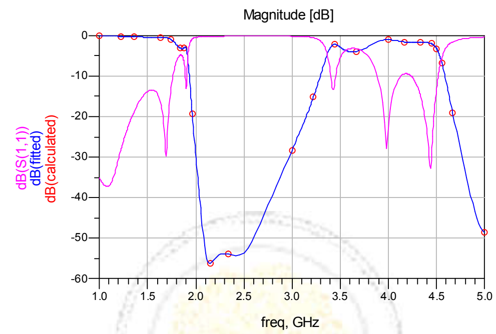

Figure 7 Series feed split ring resonator Return loss and Insertion loss.

The graph shows the Insertion and return loss results, 1.8GHz to 3.4 GHz is acts as a band pass filter. This operation point is 2.4GHz. Series feed split ring resonator acts as band pass filter in 1.8GHz to 3.4GHz.

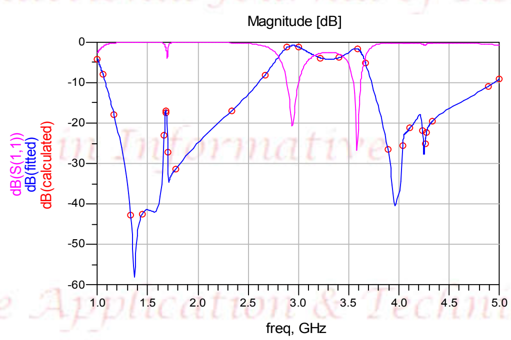

Figure 8 Corporate feed split ring resonator Return loss and Insertion loss.

The graph shows the Insertion and return loss results, 0GHz to 2.5 GHz is acts as a low pass filter. This operation point is 2.4GHz. corporate feed split ring resonator acts as low pass filter in 0 GHz to 2.5GHz.

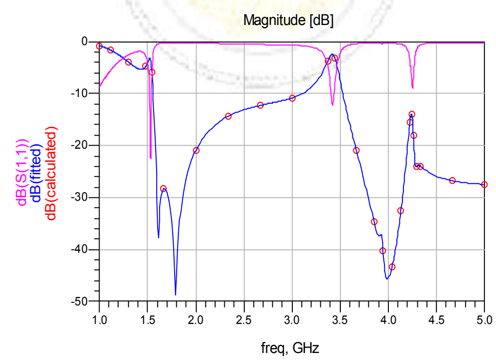

Figure 9 Parallel feed split ring resonator Return loss and Insertion loss.

The graph shows the Insertion and return loss results, 1.5GHz to 3.5 GHz is acts as a band pass filter. This operation point is 2.4GHz. Series feed split ring resonator acts as band pass filter in 1.5GHz to 3.5GHz.

5. CONCLUSION

In conclusion, we have investigated filter based on split ring resonator. Its excellent resonant characteristics and filter performances are studied and explained by using the resonators with different feed. The filter based multimode split ring resonator structure is particularly suitable for multiband and multiservice applications in wireless communication systems.

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