# A Review: Design and Development of Single and Multi Band Ring Resonator Matched Band-stop Filter

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**ABSTRACT:** In this paper, a review about the design and development of single and multi band ring resonator matched band-stop filter were presented. It is a compilation of single and multi-band ring resonator design in order to compare the techniques used and the effectiveness of each methods. Based on the reviews, it can be concluded that each methods have advantages and disadvantages. For example, DGS can increase the efficiency of the system and DGS also can provide a bulky and non conformal structure.

**Keywords:** *Ring resonator; multi-band ring resonator matched bandstop filter; DGS.*

## 1. INTRODUCTION

Multi band band-stop filters are essential in its application in telecommunication devices, where they would selectively remove bands of unwanted signals. Several effective techniques for miniaturizing filter size and converting a simple filter structure to a multi band filter without extra components have been successfully developed over the years. Multi band operating transceivers are needed in today's multi-standard wireless communication systems. Beside the multi band operation, low cost, simplicity, small occupied area and performance are desired features for these filters.

In this paper, a review about the design and development of single and multi band ring resonator matched band-stop filter were presented. Methodology in Section 2 will describe the techniques and methods used to design ring resonator and Section 3 will analyze the results obtained for each methods and discuss the performance of the methods whether the methods have advantages over the other methods.

## 2. METHODOLOGY

### 2.1 Single Band Ring Resonator

In [1], two unit cell of single split-ring resonators (SRR)-loaded coplanar waveguide (CPW) were designed. Metallic vias was used to connect the SRR to ground planes and behave like inductances $L_s$ so that the resonance frequency is switched. When the circuit works at the resonant frequency, a powerful electromotive force is gathered around the metallic vias and the SRR, which give a rise to the current in the SRR and blocks the pass band.

In [2], the filter was designed using microstrip line and composite split ring resonator (CSRR). The advantage of this filter is the ability to obtain a very high attenuation in stop band with a very low attenuation in stop and a conformal structure.

A rectangular DGS slot was added in the design of open-loop ring resonator in [3] to improve the stop and pass band parameters. DGS has unique characteristics to block certain electromagnetic waves in specified directions or frequencies and brings slow-wave movements due to L and C that were present in the circuit. In [7], SIW resonators was combine with CSRRs to change the high pass characteristics and significantly improve the rejection level of the stop-band by etching CSRRs on the top layer in the SIW resonators.

### 2.2 Multi Band Ring Resonator

In [4], several methods were discussed to implement notch band within MRR structures. There are many parameters than can be used to change the frequency of the notch filter such as the dimension of the resonator used for the band rejection, dielectric thickness of the notch and the relative permittivity of the notch layer.

In [5], multilayer technique was used. In the first step a minimize bandstop using single C-ring resonator is simulated, optimized and realized. The triple ring BPF consists of two cascaded C-ring resonators, which are placed on the RO4003 substrate, while the third ring is etched as DGS resonator on the ground plane. The both top resonators are connected with input and output through microstrip feed lines.

Two topologies of the reconfigurable C3SRRs with three concentric split-ring resonators (SRRs) had been presented in [6]. The first is related to grounding the SRRs by means of PIN diodes, and the second is related to interconnecting two adjacent SRRs, thus forming a new one. De-tunning the SRRs will increase the insertion loss.

An attractive multi-band RF planar sensor that is suitable for non-destructive testing of dispersive materials were proposed in [8]. The proposed sensor is based on a number of CSRR unit cells etched in the ground plane of the microstrip line. A new switchable absorptive band-stop to band-pass filter using dual-mode ring resonator was presented in [9]. In [10], CSRRs was introduced in the ground plane of the transmission line and the proposed structure demonstrates unique electromagnetic coupling between straight transmission line and CSRRs and leads to the creation of wide stop-bands at the desired frequencies.

## 3. RESULTS AND DISCUSSION

### 3.1 Single Band Ring Resonator

In [1], the results in the rejected band achieved good match. The maximum of insertion loss is below 30dB, which means the rejection is considerable. In [2], the frequency of filtering goes on reducing when the dimensions of CSRR was increased. Further by increasing the number of CSRR elements the attenuation offered by filter also goes on increasing.

In [3], the cut off frequencies at 3.75GHz and 7.97GHz with a bandwidth of 4.22GHz and it has 3 zeroes of transmission in rejection band. This filter is now modified by inserting a DGS slot in open loop ring resonator. It gives stop-band rejection higher than 20dB. Bandwidth size is now reduced to 1.33GHz, the DGS filter thus provides an enhanced frequency response.

In [7], by tuning the sizes and position of the CSRRs, the insertion loss of the filter is around -1dB and the return loss is less than -15dB at the frequency range of 26Ghz-29GHz and 32.5GHz-36GHz. At 29.5GHz-32GHz, the rejection level is above -20dB, which was improved by CSRRs. The total size of the proposed filter is about 8mm*7mm, indicating the proposed filter is a compact device.

### 3.2 Multi Band Ring Resonator

The size of the proposed multi-band filter using multilayer method in [5] decreases 45% compared to the previous bandstop filter using cascaded C-ring resonators. Furthermore, the filter achieves high selectivity in the transition domain. In the five-state topology in [6], five different configurations with maximum insertion loss of 2.6 B, and the total current consumption in most cases doesn't exceed 5mA was obtained. Seven-state topology provides seven different configurations using the same number of PIN diodes as in the five-state topology, but three bias voltages are necessary instead of two.

From the momentum simulation in [9], it shows that the filter exhibits pass band insertion loss around -0.24 dB and a return loss of about >13 dB in the band pass mode. The pass-band bandwidth is about 647 MHz and has a dual-mode response. It is visible in [10] that after loading multiple CSRRs in the straight spoof plasmonic transmission line, it creates stop-bands in the spectrum. A series of CSRRs have been etched from the ground plane of the spoof plasmonic waveguide which results into the creation of multiple band-stops in the operating region.

## 4. CONCLUSION

In this paper, the techniques used to design ring resonator for band stop filter was realized. There are various of methods to design ring resonator such as using metallic vias [1], using DGS [2], multilayer techniques [5] and using SIW resonators [7]. Most all the measurement results are in line with the simulated results. There is also measurement results did not agree well with the simulation results due to some factors such as the impact of metal thickness which has been neglected in simulation results because of the fabrication deviation,.

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