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A NEW Design of BSF Using Complementary Split Ring Resonator For spatial application

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Abstract— **Metamaterials are artificial pseudo-homogeneous structures with electromagnetic properties not found in nature. This article proposes a new Design of microwave band-stop filter use of complementary split ring resonator CSRRs.**
The structure is composed of a modified micro-strip line in the center and two unit cells The CSRRs modified are etched on the ground plane symmetrically in the center.

This work is a contribution that can subsequently design a new class of sensors which are miniaturized microwave biosensors capable of detecting.
The simulation was performed using Ansoft HFSS (High Frequency Structure Simulator)

Keywords—band-stop-filter,Micro-strip,Metamaterial, Complementary split ring resonator (CSRR),HFSS

I. INTRODUCTION

In recent years, new materials called (meta-materials) have features that allow developing new microwave components for new applications.
In the literature, various types of reconfigurable band stop filters were proposed [1–2].
We will talk about some studies recent and in different applications.

The first work of the team of Mr Khelil Fertas is realization a new Compact Reconfigurable Tri- Band stop Filter Using Hexagonal Metamaterial Cells for Wireless Applications [3].

Another team of Mr Becharef Kada has been working on the same concept. In this work, a a microwave Band-Stop Filter Composed of Array Rectangular Split Ring Resonators (RSRR) [4].

in the work of Mr Badr Nasiri presentations a new Microstrip band-stop filter based on double negative metamaterial This filter is an adequate solution for global system for mobile communications GSM[5].

II. COMPLEMENCTARY SPLITRING RESONATOR

The first part of this paper will be devoted to a presentation of the RAFC.
CSRRs are usually etched in the ground plane of the substrate. So compared with the SRR, the CSRR does not

occupy extra space and for this reason it is highly suitable for designing of size miniaturized microwave devices [6].

The complementary SSR has electric response and characterized by a negative effective permittivity around of its resonant frequency that can be expressed as follows [7**].**

$$f = \frac{1}{2\pi\sqrt{LC}}$$

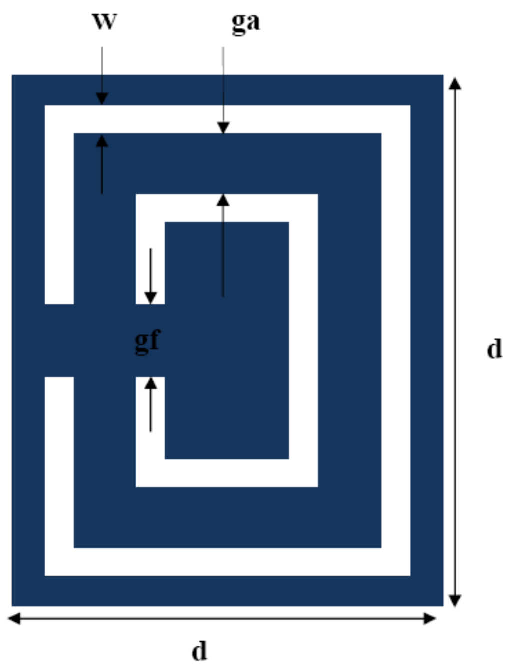

Figure.1 Geometry of the proposed CSRR unit cell

With a view to achieve some objectives in terms of final circuit size and band stop filter electrical responses, a novel metamaterial unit cell has been studied analyzed and implemented.

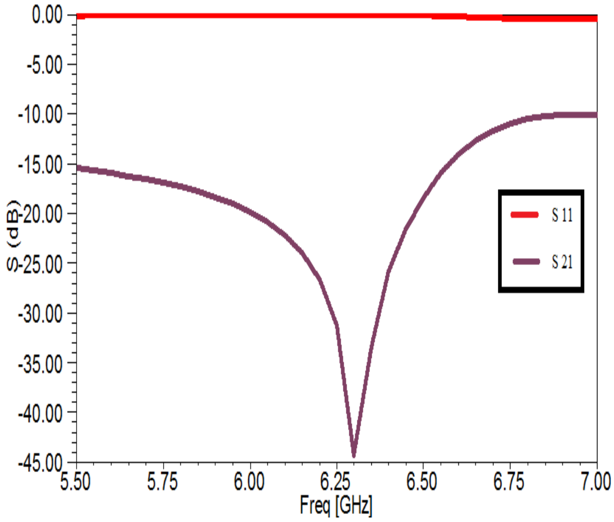

Figure.2 Geometry of the proposed CSRR unit cell

Fig. 2 shows The S-parameter simulation results show band-stop behavior around the frequency 6.3 GHz. A reflection (S11) tends towards 0dB with a very attenuated transmission (S21) around -44.2 dB.

This result confirms a band gap phenomenon around the resonant frequency of the cell.

To verify the existence of the negative permittivity, the complimentary SRR is simulated and the S-parameter Retrieval Method is used to extract the values of the effective medium parameters which are related to the response frequency of the coefficient of transmission S21 and reflexion S11 by Eq. (2), (3.), (4) and (5). **n** and **z** present respectively the refractive index the medium and impedance.[6] :

$$n = \frac{1}{k_0 d}\cos^{-1}\left[\frac{1}{2S_{21}}\left(1 - S_{11}^2 + S_{21}^2\right)\right] \quad (2)$$

$$z = \pm\sqrt{\frac{\left(1+S_{11}\right)^2 + S_{21}^2}{\left(1-S_{11}\right)^2 + S_{21}^2}} \quad (3)$$

$$\varepsilon_{eff} = \frac{n}{z} \quad (4)$$

$$\mu_{eff} = nz \quad (5)$$

Where **k0** présents a wave number equivalent to **2π/λ0**, and **d** is the thickness of the substrate used in the design of the metamaterial resonator.

III. THE PROPOSED BAND-STOP FILTER

the proposed filter was developed using the commercial simulator HFSS.

The structure is composed of a modified micro-strip line in the center and two unit cells The square CSRRs modified are etched on the ground plane symmetrically in the center.

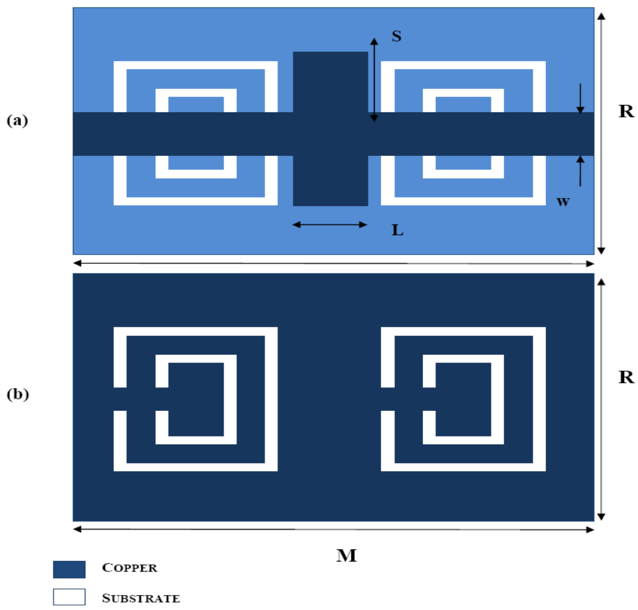

Figure 3. Design steps of BSF (a) top view (b) Bottom view

To reduce the size of the previous band stop filter, we used the geometric parameters of are presented in Table I.

parameters	d	ga	gf	w	L	S	M	R
Value mm	4.8	0.85	0.3	2	2.5	1.4	19	10

Table 1. geometric parameters

IV. RESULTS AND DISCUSSION

the continuation of our approach The structure is simulated for the frequency band [**1-10**] GHz ;The substrate used for the simulation is FR4-epoxy which has a relative permittivity of 4.4, tangential losses of around 0.002 and a thickness of 1.6 mm. With geometric parameters of are presented in Table I.

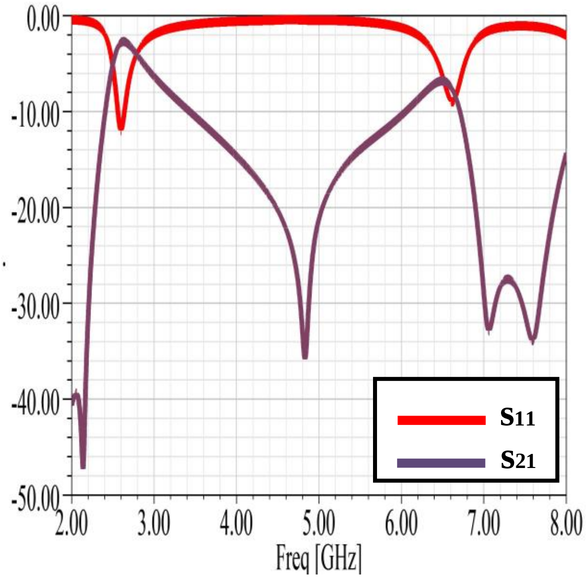

Figure 4 . S-parameters results of the final designed microstrip band stop filter

the simulated insertion loss **(S21)** and return loss **(S11)** of this filter. The maximum attenuation of |***S*21**| is approximately **– 39** dB at **4.8** GHz and the bandwidth of stop band is equal to **390** MHz

There are many Parameters which affect extremely on the resonance frequency such as:

-Geometric parameters of the CSRR cells

-Substrate type and their thickness

Among this parameters In order to study the effect and the influence of substrate type

substrate type	Relative Permittivity	resonant frequency / GHz
FR4-epoxy	**4.4**	**4.8**
Rogers RT/Duroid 6002	**2.94**	**5.9**
Rogers RO4003	**3.55**	**5.39**
Rogers RT/Duroid 5870	**2.33**	**3.2**
Rogers RO3006	**6.15**	**4.2**
Rogers RO3010	**10.2**	**3.2**

Table 1: Substrate effect on Resonance Frequency of the BSF

Following several optimization simulations presented in Table 2, we notice the variation in resonant frequency as a function of the relative permittivity

$$f\,r = F\,(\varepsilon_r)$$

According to the analyzes above it is obvious that the Relative Permittivity of Substrate and The effective parameter to control the resonant frequency

The solution to reduce their size is to use substrates with high permittivity [9].

The resonant frequency shift caused by changes in the dielectric environment can be used to determine properties of a material.

The Next work is based on the interaction of an electric field with the biological material under test at the resonant frequency of the structure.

The performance of the proposed BSF circuit is compared to the filters reported in the literature in terms of the rejected band properties. This circuit has good characteristics which make it acceptable for many applications

Parameters/ Ref	Rejected Band (GHz)	FBW	S21 deep	Size mm^2
[3]	**[5. 8- 6]**	**1.82%**	**35 dB**	**280**
[4]	**[2.09-3.7]**	**26%**	**30 dB**	**320**
[5]	**[1. 5- 2.3]**	**40%**	**30 dB**	**252**
This work	**[2. 6- 6.5]**	**80%**	**36 dB**	**190**

Table 3. Performance comparison of band stop filter.

V. CONCLUSION AND PERSPECTIVES

In this paper, a compact band stop filter based on RAFCs have been proposed, successfully designed and simulated.

In perspective, we propose the extension of this work by using this new band stop filter structure for the design of new miniaturized microwave biosensors capable of detecting solids and liquids of unknown physical properties.

Simplicity and speed of analysis are the main advantages of a biosensor

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