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Notch Filter Designing With SRR Materials for Wireless Applications

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ABSTRACT: **In this research a notch filter has been designed using srr metamaterial for 7.55 GHz. Filter designed will be used to suppress electromagnetic interference between various elements of monolithic circuits. Filter characteristics of srr are presented by inserting srr into microstrip line. These filters have a wide application in the field of wireless communication in RF front end devices.**

Keywords: microstrip line, metamaterials, split ring resonators, band stop filter.

1. INTRODUCTION

Veselago[1] in 1968 had presented aspects of double negative metamaterials Metamaterials can be engineered to have a particular electromagnetic behavior that is readily not possible with any of the natural materials. Electromagnetic behavior of any materials possesses can be explained in terms of two parameters named as permeability and permitivity. All natural occurring materials have positive sign for both these parameters; however for matamaterials permittivity as well as permability can hold positive or negative sign. Hence the refractive index which is square root of permittivity as well as permeability can hold values which can be positive , zero or negative. We will use this property of metamaterial to design filter. The filter designed will be inserted into microstrip line and transmission parameters of microstrip line and microstrip line inserted with SRR will be compared to explain the filter characteristics of metamaterial filter.

1.1 MICROSTRIP LINE

Microstrip transmission line is used as planar transmission line in Radio frequency (RF) applications. The structure of microstrip line is presented in fig(1) having dielectric substrate, the one side of which is metalized ground and the other side has a thin conducting strip of width 'w' and thickness 't'.

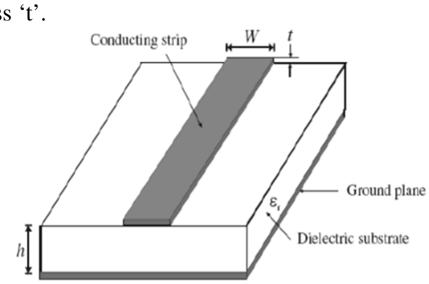


Fig.1. General microstrip structure

Design parameters of microstrip line as given by [2]. Here ε_e is the effective dielectric constant of the structure.

ε_r is the dielectric constant of the structure.
W is the width of microstrip line and t is the thickness of microstrip line.

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\,\frac{1}{\sqrt{1+12\,d/W}} \qquad (1)$$

where,

$$\frac{W}{d} = \frac{8e^{A}}{e^{2A} - 2} \qquad \text{for } \frac{W}{d} < 2 \qquad (2)$$

$$= \frac{2}{\pi}\left[B - 1 - \ln(2B-1) + \frac{\epsilon_r - 1}{2\epsilon_r}\left\{\ln(B-1) + 0.39 - \frac{0.61}{\epsilon_r}\right\}\right] \qquad \text{for } \frac{W}{d} > 2 \qquad (3)$$

$$A = \frac{Z_o}{60}\sqrt{\frac{\varepsilon_r+1}{2}} + \frac{\varepsilon_r - 1}{\varepsilon_r + 1}\left(0.23 + \frac{0.11}{\varepsilon_r}\right) \qquad (4)$$

$$B = \frac{377\,\pi}{2Z_o\sqrt{\varepsilon_r}} \qquad (5)$$

The characteristic impedance is approximated by:

$$Z_0 = \left\{ \frac{60}{\sqrt{\varepsilon}}\ln\left(\frac{8d}{W} + \frac{W}{4d}\right) \qquad \text{for } \frac{W}{d} \le 1 \qquad (6)\right.$$

$$= \frac{120\,\pi}{\sqrt{\varepsilon}\left[0.667\ln\left(\frac{W}{d} + 1.444\right) + 1.393 + \frac{W}{d}\right]} \qquad \text{for } \frac{W}{d} \ge 1 \qquad (7)$$

1.2 SPLIT RING RESONATOR (SRR)

Here we are using SRR metamaterial to act as filter. The structure of SRR is as shown in the figure.2. Here a depicts the external radius of ring,r depicts the internal radius of ring, d is the distance between the two rings, c indicates the width of ring and the split gap

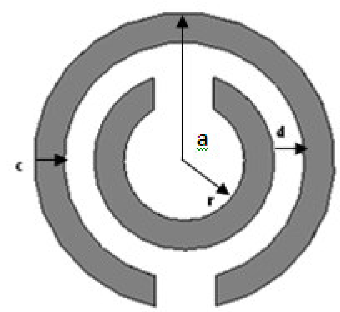
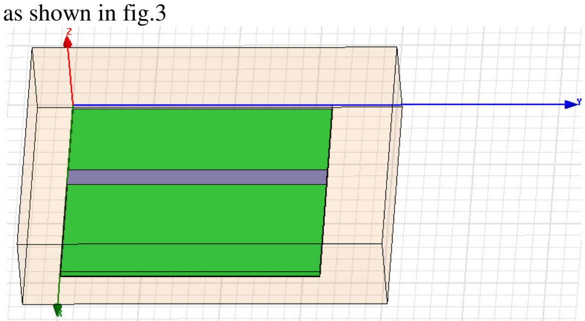


Fig.2. Structure showing physical dimensions of SRR

These loops are made of conducting material. A magnetic flux which is penetrating the metal rings will induce rotating currents in the rings, producing their own flux to enhance or oppose the incident field (depending on SRRs resonant properties) negative dielectric constant of some other structure so as to produce negative refractive index materials[7].

2. DESIGN AND RESULTS OF FILTER WITH SRR

The sttructure of microstrip line as designed by HFSS is as shown in fig.3



2. Structure of microstrip line

The parameters of interest of microstrio line are as given in table (1).

Object	Material	Dielectric constant	Width	Thickness
Ground Plane	PEC	1	32	0.05mm
Substrate	RT duroid 5880	2.2	32	0.794mm
Microstrip line	PEC	1	2.46	0.05mm

Table.1.. Dimensions of microstrip line

Transmission scattering parameter S_{12} of transmission line are as shown in fig . The attenuation of signal when it passes from port 1 to port 2 is 0 dB. It indicates that signal is propagating from por(1) to port (2) without attenuation.

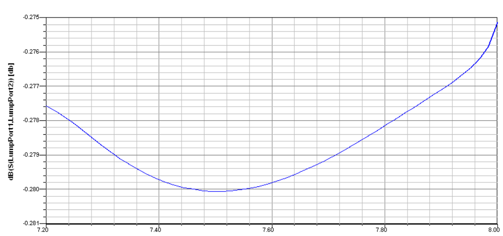
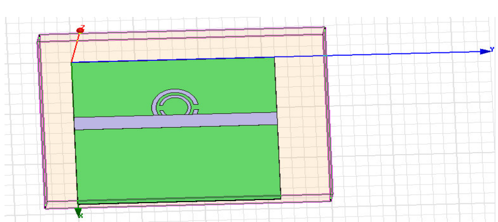


Fig.4. Structure of microtsrip line (a) Front view(b)Simulated scattering parameter(S12)

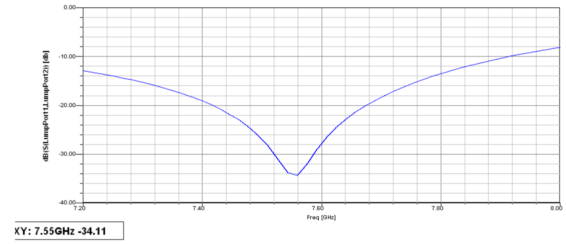
The structure obtained by inserting SRR into microstrip line is as shown in fig



(a)

The parameters of SRR used in our design are Outer radius 3.7mm, internal radius 2.5mm, gap .5mm.

The transmitted scattering parameters of microstrip line loaded with SRR are as shown in fig () .



This insicates that microstrip line loaded with srr is not allowing signal of frequency to pass through this structure. Hence srr is acting as filter at frequency of .

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