# Dual-Band Pass Filter with Wide Band-Frequency Rejection

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## ABSTRACT

A Dual band Filter block has been highly attention due to its highly importance in wireless communication systems. High frequency level normally companies with the performance of filter block. The use of both low-pass or band-stop filter and the step-impedance lines methods to reduce the spurious characteristics of the filter are not a practical solution since that adds more complexity and large in size. The proposed microstrip filter was utilized for Industrial Scientific and Medical (ISM) applications (2.45 GHz) with -25 dB with twice transmission zeroes as a first band while the second band of (3.5-8 GHz) for LTE and wireless LAN applications with return loss up-to -15 dB. (CST) Computer Simulation Technology was used to simulate the declared structure. The dual band, mode simulation results have been extracted and also compared with the literature that get closed to each other. So that, the computer aided design gives a good pointer to adopt an extracting result that have been obtained using the aforementioned simulator.

**Keywords:** Dual-Band Pass Filter, Wide Band-Frequency Rejection.

## 1. Introduction

A novel dual mode substrate integrated waveguide filter with mixed source-load coupling (mslc) is presented [7]. Ziqiang Xu et al, are demonstrated an interdigital slot-line (ISL) to introduce mixed coupling between source and load, the proposed filter with only one cavity could have three transmission zeros which can be controlled flexibly. However, them work still has many weaknesses in terms of volume, complexity and cost. In a related context, Shoujia Sun et al, they embedded two pairs of loaded open stubs to control on each band [8]. In this literature, among these RF/Microwave devices, RF/Microwave microstrip band pass filter (BPF) combined with metamaterial unit cell is selected. Most of the proposed articles are used split ring resonators (SRR) and complementary split ring resonators (CSRR) as a major component in different types of metamaterial circuit design [1-5]. S.S. Karthikeyan and Rakhesh Singh Kshetrimayum are used CSRR to eliminate the second harmonic response of the BPF by etching the CSRR on the ground plane of the BPF structure [6]. The out-off-band and the spurious frequency of the BPF were improved and eliminated respectively by combined the CSRR with short circuited stub of the Chebyshev BPF [7]. The rejection of high performance local area network (HiPerLAN) interference in the BPF spectrum by integrating the BPF with CSRR is proposed by [9]. The unwanted wireless local-area network (WLAN) frequency band is notched by employing the split ring resonator defected on ground plane of BPF [10]. Spurious frequency suppression and level rejection through combining CSRR with the conventional BPF structure was achieved by [11]. In addition, a conventional Chebyshev BPF was used and exhibits very low characteristic parameters in terms of second harmonic and return loss [8]. However, all the proposed earlier articles has been improved second harmonic or notched either HiPerLAN or WLAN of BPF spectrum frequency band. In this paper, CSRR etched on the ground plane has been proposed and considered as a more suitable method to solve three important filter problems ; third order harmonic characteristic suppression (3fo), return loss and the notched frequency band of professional wireless microphone system (PWMS). Through the combination between the single unit cell of CSRR with a conventional filter with no change in BPF size with less complexity.

## 2. Research Method

Microstrip BPF type Chebyshev response consists of five poles short-circuit stubs is designed on the parametric geometry shown in Table 1 and elected according to the designing equations [8]:

$$\theta = \pi/2(1 - FBW/2)$$

$$J_{1,2}/Y_o = g_o\sqrt{hg_1/g_2}, \qquad J_{n-1,n}/Y_o = g_o\sqrt{hg_1 g_{n+1}/g_o g_{n-1}}$$

$$J_{i,i+1}/Y_o = hg_o g_1/\sqrt{g_i g_{i+1}} \qquad for \quad i = 2 \; to \; n-2$$

$$N_{i,i+1} = \sqrt{(J_{i,i+1}/Y_o)^2 + (hg_o g_1 \tan\theta/2)^2} \qquad for \;\; i = 1 \; to \; n-1$$

$$Y_1 = g_o Y_o (1 - h/2) g_1 \tan\theta + Y_o (N_{1,2} - J_{1,2}/Y_o)$$

$$Y_n = Y_o (g_n g_{n+1} - g_o g_1 h/2) \tan\theta + Y_o (N_{n-1,n} - J_{n-1,n}/Y_o)$$

$$Y_i = Y_o (N_{i-1,i} + N_{i,i+1} - J_{i-1,i}/Y_o - J_{i,i+1}/Y_o) \qquad for \quad i = 2 \; to \; n-1$$

$$Y_{i,i+1} = Y_o (J_{i,i+1}/Y_o) \qquad for \quad i = 1 \; to \; n-1$$

where $Y_i$ represent the characteristic admittances, $Y_{i,i+1}$: the characteristic admittances of the lines connecting between tow stubs, $g_n$ are the prototype low pass filter elements, $h$ is the dimensionless constant and $\theta$ is the electric length of the quarter guided wavelength at midband frequency $f_o$. BPF center frequency of $f_o$ =2GHz, 0.5 fractional bandwidth and 0.1 dB ripple in the pass band. . An equivalent impedance of feed line is equal to 50Ω. BPF structure is based on (Rogers RO3010) substrate with dielectric constant of Ɛ = 10.2 and thickness (*t*) equal to 0.63 mm is used as indicated in Fig.1.a.

**Table (1) the parametric geometry of band-pass filter based on (8)**

| $i$ | $W_i$ (mm) | $\lambda_{gi}/4$ (mm) | $W_{i,i+1}$ (mm) | $\lambda_{gi,i+1}/4$ (mm) |
|---|---|---|---|---|
| 1 | 1.51 | 12.67 | 0.93 | 13.03 |
| 2 | 3.8 | 12.07 | 1.13 | 12.97 |
| 3 | 3.93 | 12.03 | 1.13 | 12.97 |
| 4 | 3.8 | 12.07 | 0.93 | 13.03 |
| 5 | 1.51 | 12.67 | | |

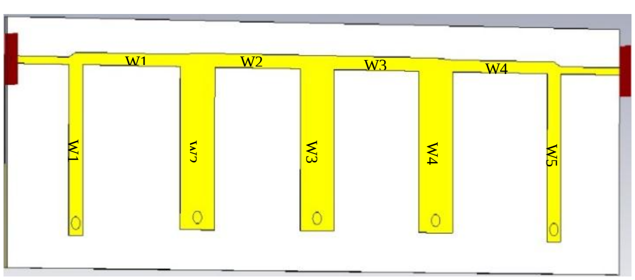


Fig.1a Chebyshev BPF short circuit

CSRR unit cell with the following specifications: 7X7 mm, s= 0.3mm, d= 0.3mm, g=0.3mm; outer ring side width, inner and outer ring spacing, width of the inner or outer ring and the gap of the split ring respectively is carried out as shown in Fig.1. b.

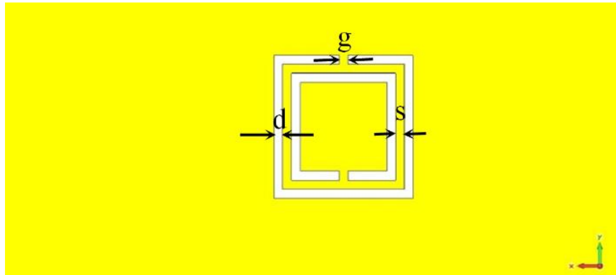


Fig.1b a single unit cell CSRR etched on

CSRR is engraved, underneath the central stub of the BPF, on the ground plane of the using substrate. The software package namely computer simulation technology (CST) software is employed. The S- parameter of the new structure BPF based on CSRR represented by return loss and insertion loss are carried out using CST software.

## 3. Simulation Results

A new structure consists of Chebyshev BPF with CSRR etched in the ground plane was pieced together on a Rogers RT/Duroid 3010 ( =10.2, thickness t=0.635mm). Figure 2 illustrates the S-parameters which represent the reflection and the insertion loss of the conventional BPF as a function of frequency band that offered by [8].

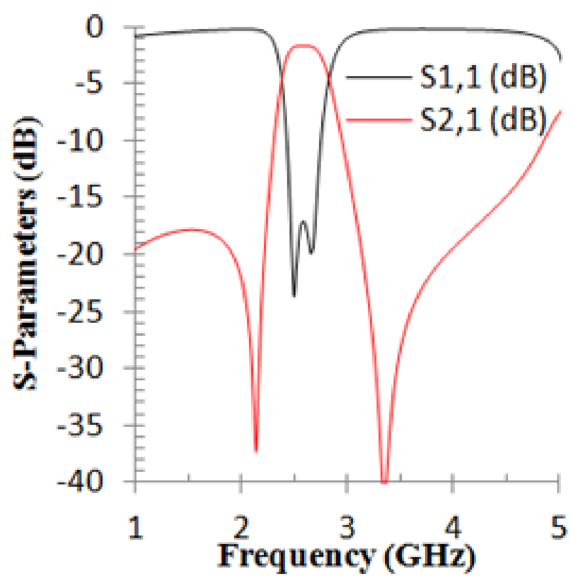


Fig.2 S-Parameters for conventional band pass filter [8]

On the other hand, the obtained response has two transmission poles focused at 2.45 GHz with more than -25dB and two transmission zeros left one at 2.1 GHz while the right one at 3.3 GHz. on the same context, the second step of dual-mode, band BPF is to do some modifications in the width of specific ribs to provide the second band at 5.35 GHz while the first frequency band still in the same frequency response (2.45 GHz) as shown in Fig. 3.

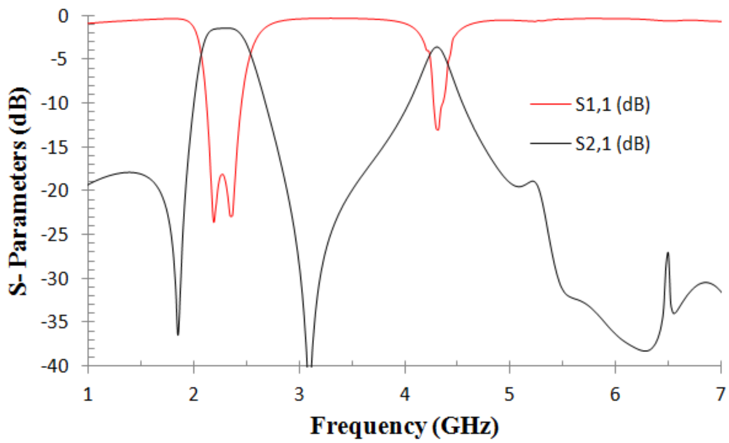


Fig.3 S-Parameters for BPF combined with CSRR

Based on the output S-parameter, we see the CSRR with size of 7X7 mm, s represents the inner and outer ring spacing of 0.4 mm, $d_1$ acts as width of the inner and outer ring of 0.4 mm and g is the gap of the CSRR of 0.5 mm, was affecting on the second frequency band to achieve an enhancement in the reflection coefficient parameter ($S_{11}$) more than -15 dB and insertion loss parameter ($S_{21}$) more than -37 dB. Moreover, pair of transmission pole and transmission zero (5, 5.3 GHz) and (3.35, 7.8 GHz) respectively

## 4. Conclusion

In this paper, the insertion and the return loss transmission characteristics of band-pass filter has been studied. The influence of pieced complementary split ring resonators with band-pass filter structure has been offered. The third harmonic spurious was suppressed more than -10dB. 15 dB less of return loss and notched frequency band of professional wireless microphone system (PWMS) are achieved comparing to the conventional structure due to two significant reasons; the good matching between the resonance frequencies of both the CSRR unit cell and BPF, and a high coupling through etching the CSRR in appropriate location. Finally, the suggested structure displays no increases in size with less complexity in the structure.

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