An Enhanced Miniature Dual-Mode, Band Microstrip Bandpass Filter Based Single CSRR

Mushtaq A. Alqaisy 1,*, Amar A. Mahawish2, Ghadah M.Faisal3

1,2 Computer Engineering Department, College of Engineering, Al-iraqia University, Baghdad, Iraq
3 Electrical Engineering Department, College of Engineering, Al-iraqia University, Baghdad, Iraq

1. Introduction

One of the priorities of today's need in the design of the microstrip filters is size, weight and cost. So, the dual mode, band microstrip (BPF) based on Complementary Split Ring Resonator (CSRR) graved on the ground plane is a good choice for that priorities [1-2]. On the other hand, a dual band, mode microstrip (BPF) is an essential item of a transceiver stage in wireless systems to overcome the bulk and complexity of the circuit [3-4]. So that, the combination between the effects of dual mode, band microstrip bandpass filter and CSRR is a logical choice to settle most of the well-known challenges [5-6]. numerous cited dual-mode, band (BPFs) works based on CSRR have been proposed [7-11].

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, these works still have 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]. Anyway, hard effort and time are needed. In this methodology, the second band out of control is very clear in the S-parameters of the simulated and measured results. Mushtaq Alqaisy et al., have suggested a dual-band bandpass filter using single unit cell of complementary split ring resonator with third harmonic reduction. They used the ground plane of the open stub structure to enhance the insertion loss of the designed band-pass filter. However, the overall structure suffered from bulky dimensions and less enhancement in second band frequency response [9]. An output/input based on a single-layer substrate with dual-band triple-transmission pole resonator is displayed. A double from open stub framework is building on the combined microstrip-to-CPW technique to achieve the desired structure [10]. Wen Chen et al., have been proposed a single folded short-stub-loaded resonator SIR mixed with source load coupling to get a compact and acceptable selective dual-mode dual-band microstrip BPF [11]. A dual-band dual-mode microstrip BPF based on the second order of Sierpinski fractal-based resonator (SFR) is demonstrated. And also, [12] P. Ma et al., provides an alternative way to design dual-mode dual-band planar filters, which can easily be implemented with HTS thin film technology. However, most of the above articles either have complexity in the main framework or an expensive component, substrate and procedure of fabrication. On the other hand, some of cited one are utilized extra items for degenerate the dual-mode.

In this article, an enhanced dual-band, mode microstrip bandpass filter based on complementary split ring resonator is proposed. The declared BPF has a very clear transmission zeros in other sides of the elementary frequency-band with good selective edges. Meanwhile, the other frequency-band has a very clear boundaries comparing with cited filter without using CSRR in the ground plain [15]. Moreover, the outstanding features of microstrip filter use a cheap material, simplicity in methodology and ultimately an acceptable performance.

2. Filter Design

The simple composition of a meander square ring resonator technique with small patch joined on one corner for dual mode characteristics is shown in Fig. 1. The proposed filter consists of four arms. Initially, each side has different electrical lengths $\theta_1$ and $\theta_2$ provides different impedance $z_1$ and $z_2$[13]. In this article, $\theta_1$ is chosen to be three-fold of $\theta_2$, the initial frequency resonates at

$$R_z = \tan^2 \theta_o$$ (1)

where $R_z$ is the ratio of $z_1$ divided by $z_2$, and the electrical length $\theta_o$ is the primary resonant frequency at $f_o$. The elementary spurious frequency band occurs at

$$\tan \theta_s = \infty$$ (2)

where $\theta_s$ is the electrical length for the elementary spurious frequency band $f_s$. From (1) and (2), we get

$$f_s/f_o = \theta_s/\theta_o = \pi/(2\tan^{-1}\sqrt{R_z})$$ (3)

It is obviously from (3) that the resonant frequency band can be alter by the ratio of the characteristic impedance $R_z$. In this demonstrated filter, first and second frequency bands $f_o$ and $f_s$ are adjusting to be 2.45 GHz and 5.35GHz, respectively.
At First, the dual mode, band microstrip (BPF) has been prepared on Rogers RO 3010 (lossy) with thickness (h) of 1.6 mm and relative dielectric constant ($\varepsilon_r$) 10.2, the overall filter dimension is very small of (12x12) mm. Furthermore, some modification in the width of meander sides have been utilized for second band response. At the end, the final characteristics of this structure are w1 =0.2 mm, w2=0.8 mm and w3=4.3 mm. On the other hand, a complementary split ring resonator was graved on the ground plane, as shown in the Fig. 2, of the proposed filter to get an enhancement response in the second frequency band. Finally, a dual-mode, band microstrip (BPF) with compact in size has been established and investigated using computer aided design technology (CST) [14].

3. Simulation and Comparison Results

First, we will prepare the design of simulated (BPF). The proposed (BPF) was built on a well-known substrate (Rogers 3030) with a height of 1.6 mm and a relative dielectric constant of 10.2. In this paper, the declared microstrip (BPF) with dual-mode response was constructed and confirmed using CST, simulator package, as shown in Fig.3(b). S-parameters frequency responses of the proposed filter have been compared with the cited results in [14,15] to verify the possibility of working the simulator (CST) for obtaining the expected results, as shown in Fig.3(a).
On the other hand, the obtained response has two transmission poles focused at 2.45 GHz with more than -25 dB 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. 4.

For the inspection in the results, the first band gained as a result of a square loop ring resonator with dual mode as a result of small patch was joined in one corner, while, the other band created as a result of the altered in the sides of the square loop resonator. Furthermore, based on the complementary split ring resonator was graved and designed in the ground plan to enhance the second frequency band response (S-parameters) is very obvious and announced in Fig. 5.
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, d1 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 (S11) more than -15 dB and insertion loss parameter (S21) more than -37 dB. Moreover, pair of transmission pole and transmission zero (5, 5.3 GHz) and (3.35, 7.8 GHz) respectively.

4. Conclusions

An Enhanced Miniature Dual-mode Band Microstrip Bandpass Filter Based single CSRR using square copper attached at one corner to perturbate desired mode and altered impedance resonator to create a second band of a square ring loop resonator has been suggested. A dual mode microstrip BPF of this type with 35.64% bandwidth with more than -25 dB at centre frequency of 2.45 GHz has been achieved and simulated to prove the construction of miniature microstrip BPF. On a related context, for alteration process to the arms of square ring loop has been utilized to produce the other band of the prepared dual-band BPF. Finally, a CSRR was graved at the ground plan of the reported structure to enhance the second band of the proposed filter with reflection coefficient parameter (S11) more than -15 dB and insertion loss parameter (S21) more than -37 dB. Moreover, pair of transmission pole and transmission zero (5, 5.3 GHz) and (3.35, 7.8 GHz) respectively.

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References


