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Microstrip Bandstop Filter using Double Spirals

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Abstract

This paper presents a design and simulation of double spiral resonator bandstop filter (BSF) with double spurlines configurations. In order to enhance the BSF performance, the double spurline were used. The desinged BSF was characterized by using vector network analyser for S-parameter measurement. In experimental results, we achieved an insertion loss (S21) of less than 42.1 dB and return loss (S11) is below 0.03 dB at 3.2 GHz with the bandwidth of 1.73 GHz. The bandwidth of it is wide enough for the wideband application. The simulation and measurement results are almost the same and we can also use this configuration to fabricate the integrated passive device (IPD) due to miniaturization. The randomely simulated current distribution results also show good performance of the designed BSF. The physical size of the designed BSF is (5.6 × 20) mm^2.

Keywords: *Spiral bandstop filter, spurlines resonator, microstrip BSF, spurline BSF, wideband bandstop filter.*

1. INTRODUCTION

Harmonic suppression and noise (or interferences) removal is very important task in wireless transceiver design. In order to eliminate those components added in the signal, we need bandstop filter (BSF). Therefore, we designed microstrip compact BSF for wireless transceiver system with low cost and light weight. The trend of designing the bandstop filters like a BSF with open-circuited stubs, a BSF with cross-coupling stubs, a square split ring BSF, stepped impedance resonator BSF, and a BSF using a square loop resonator, were popular to have bandstop characteristics with low insertion loss, deeper rejection and highly integrated patterns [1-4]. However, to make it more compact and to get higher device performance for the wireless communication system, we can also consider double spirals with double spurline at both sides (input and output ports) terminating with 50 Ohm to reduce the harmonics and get good bandstop characteristics. Such design layout pattern can have advantageous towards improvement of the device performance [5, 6]. Therefore, in this work, we applied double spurlines in each part in the double spurline BSF to achieve a stopband responses with good reflection zeros and this design layout pattern can overcome the problems involved with harmonics, miniaturization, ease of fabrication and low material cost relative to other various types of resonators such as hairpin resonators, stepped impedance resonators (SIR), ring resonators, parallel line resonators and so on.

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3. DESIGN AND SIMULATION

We designed a compact double spiral resonator bandstop filter with double spurlines and simulated using the SONNET 3D electromagnetic simulator. The design and simulation was based on a Teflon substrate with a thickness of 0.54 mm and dielectric constant of 2.54. The designed layout pattern of the BSF is shown in Figure. 1. In this work, the calculated value of the double spiral length, Ls was 0.203 times the guided wavelength (λg). The gap between two spirals and turn spacing were C_G and Cg were optimized to 0.65 and 0.5mm respectively. The length and width of the whole spurlines were 0.3 mm and 0.2 mm respectively and these spurlines assist to suppress the harmonics and enhance reflection zero characteristics. The size can be optimized using the heights, h1 and h2 which were set to 2.3 mm. The distance, D between spurlines in both sides of the ports was 3.5 mm. The reference lines in both ports were 2 mm and the width, W of the reference line was 1 mm and both ports were terminated at 50 Ω.

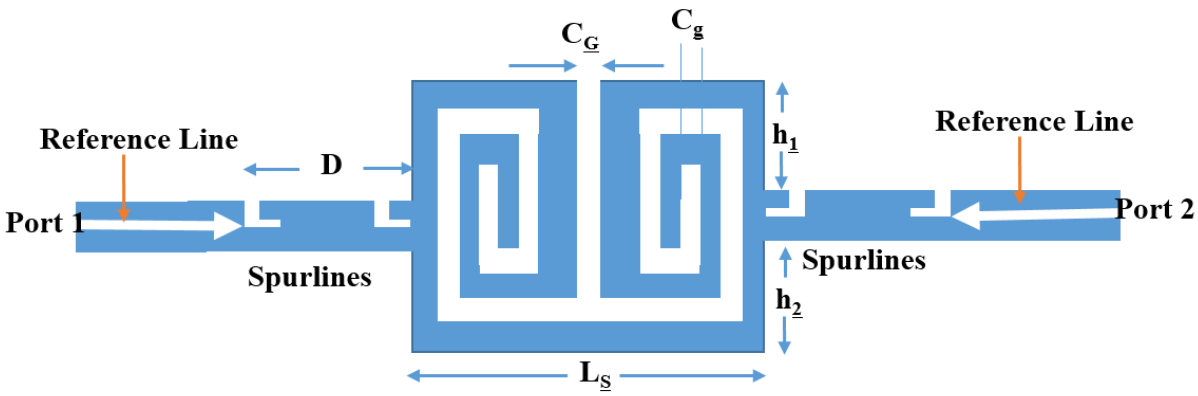


Figure 1. Layout of designed BSF with spurlines

The S-parameters are very important parameters that were used to evaluate the transmission and reflection coefficient. In case of bandstop filter, the selective rejection of bandwidth is important. The simulated result of the BSF is depicted in Figure 2 and the insertion loss (S21) and return loss (S11) of 42.1 and 0.03 dB respectively at the center operating frequency of 3.2 GHz were achieved. The transmission zero was improved simultaneously with harmonics as well. The general equation for calculating the resonance frequency is shown in equation 1 where *L* and *C* represent inductance (in henry) and capacitance (in farad) .The guided wavelength of microstrip line used for designing BSF can be estimated by equation (2).

$$f = \frac{1}{2\pi\sqrt{LC}} \quad \text{.....(1)}$$

$$\lambda_g = \frac{\lambda}{\sqrt{\varepsilon_{eff}}} = \frac{C}{f_{bs}\sqrt{\varepsilon_{eff}}} \quad \text{.....(2)}$$

where, L is the length of the spurline, C is the speed of light (3×108 m/s), f_{bs} is the center frequency for bandstop filter, and ε_{eff} is the effective permittivity of the substrate [6].

The simulation result is plotted as shown in Figure 2 which has a dual mode with the insertion loss (S21) and return loss (S11) of 0.03 dB and 42.1 dB respectively at the center operating a frequency of 3.2 GHz with 3 dB bandwidth of 1.70 GHz. The resulted bandwidth was very wide which is good for eliminating the harmonics and channel interferences of the system.

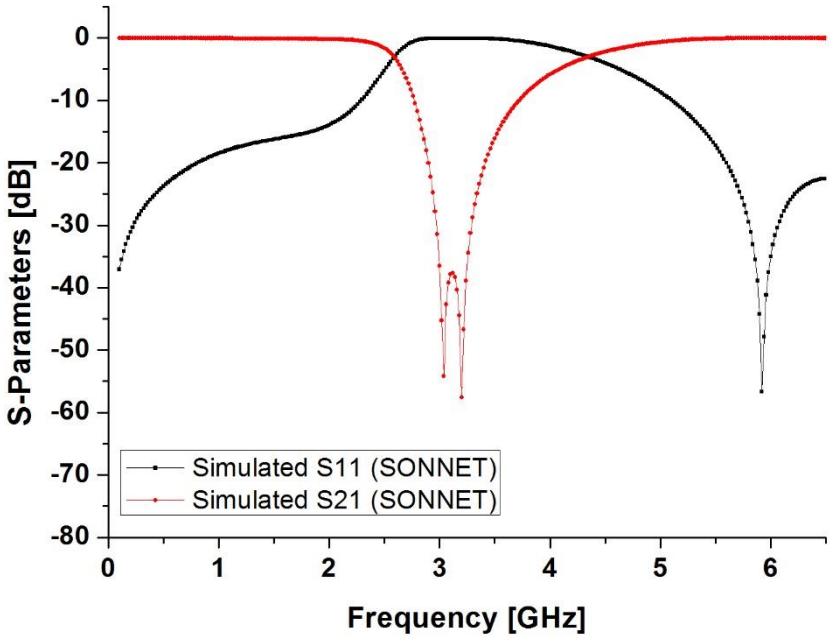


Figure 2. Simulation result of designed BSF with spurlines

3. CURRENT DISTRIBUTION

The design BSF can be verified in terms of the random simulation of current density which was carried out using SOONET electromagnetic simulation tool. The random simulations were done with 1.8 GHz, 2.5 GHz, 3.2 GHz and 5.9 GHz. These frequencies were entirely rejected indicated by blue color. Figure 3 shows the current density distribution of the designed layout pattern of BSF in various random frequencies.

4. CONCLUSION

We developed the reduced size of double spiral with double spurline resonator bandstop filter. In order to eliminate the harmonics and noises of the system, we implemented the double spurline technique to obtain good device performance. The designed bandstop filter demonstrated a wide and deep rejection bandwidth of approximately 1.7 GHz, which can be possible to apply to the wide band application. The simulated insertion loss and return loss showed the rejection and passband frequencies which are very important for the BSF desing. We can expect the further reduction in size by using integrated passive device (IPD) technology with good device performance.

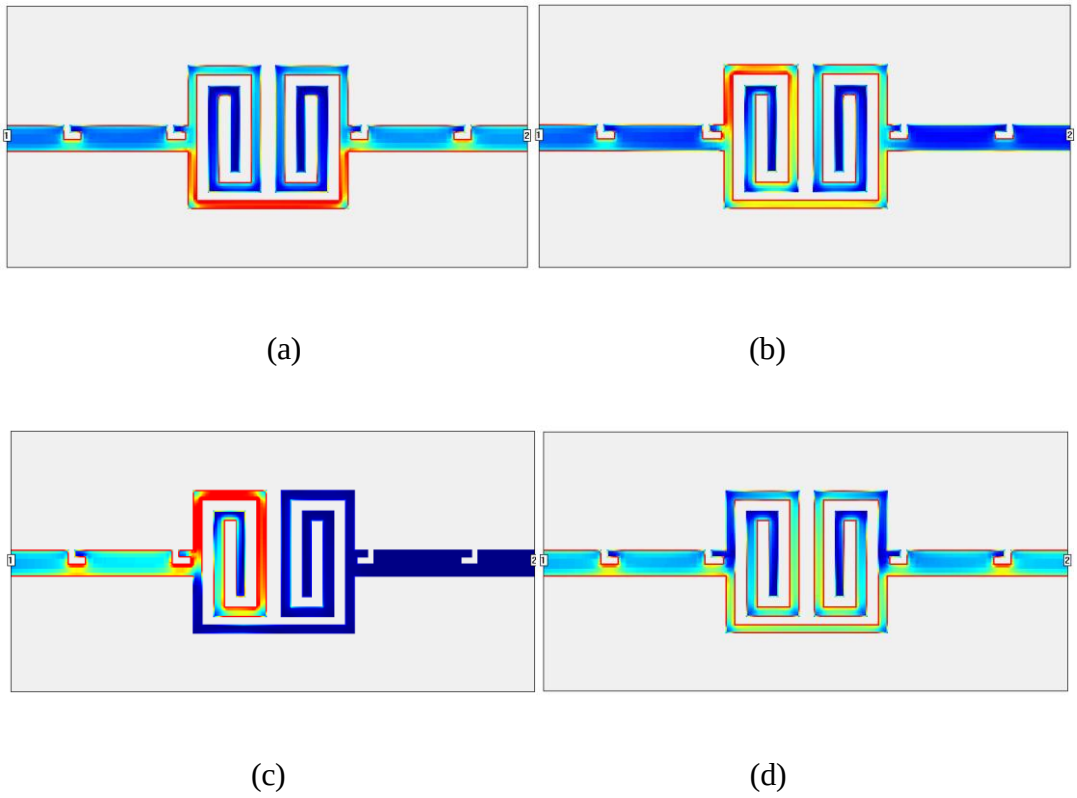


Figure 3. Current density distribution at (a) 1.8 GHz, (b) 2.5 GHz, (c) 3.2 GHz and (d) 5.9 GHz

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