Folded Tapered-Line Resonators Bandpass Filter with Tuning Slits for Suppressing Unused Signals

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Abstract

This paper presents the study, designing and measurement of the microstrip bandpass filters which consists of two folded tapered-line resonators coupling together. The tuning slits are added in the end of the resonators for suppressing the unwanted signals. This prototype operates at the center frequency of 2.4 GHz. The measured insertion loss is -1.1 dB and return loss is around -15.1 dB. The simulated results are agreed very well with the measured results. The proposed bandpass Filter can be applied for WLAN.

Keywords : Tapered-Line Folded Resonator Slit

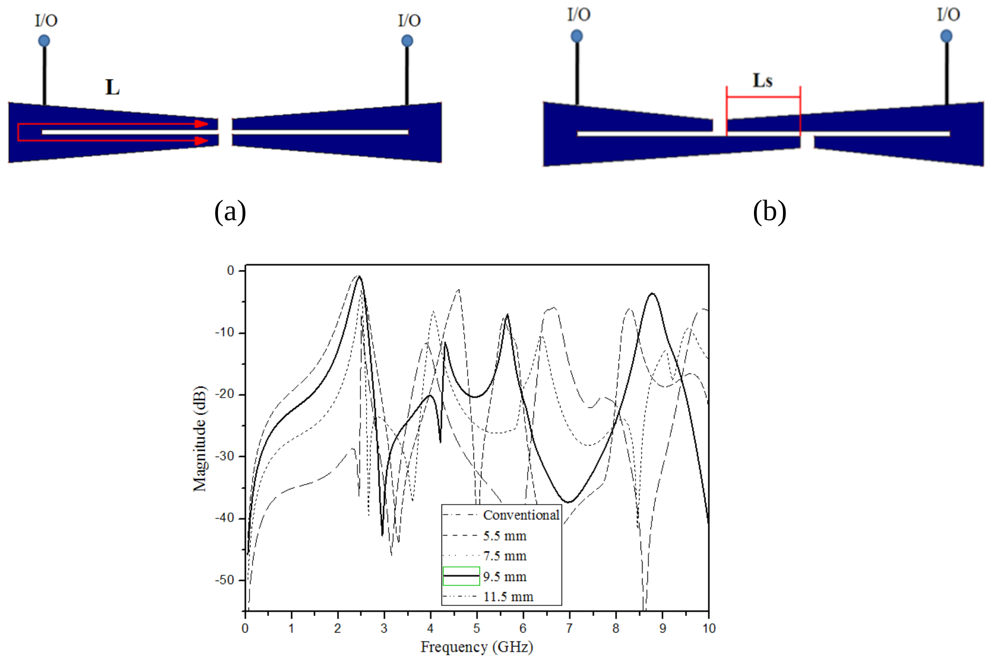
1. Introduction

Bandpass filter is used widely in wireless communications, microwave frequency. Mostly, it uses the structures to be straight the microstrip line that have researched and developed continuously. The advantage of deciding the microstrip line to create a bandpass filter is small, lightweight, very reasonable, better performance and easy to design. In the present, the role and importance of communication technology have advanced and rapidly and constantly grown in transmission of information, both wired and wireless. In wireless communication system, it needs to have the good design of the system to suit the performance. Also, the bandpass filter must be respond well and reduce the harmonic frequency or the unwanted signals

Actually, the techniques for reducing unused signal, it found that the structure of the resonators to be step impedance resonator (SIR) in [1] is the basically structure is proposed. After that, the size of resonators has been developed to be smaller by using the structure of hairpin, open-loop resonators or coupled line resonators [2-4]. The folded tapered-line resonator is another configuration that is interesting to be fabricated but its responses produce the harmonic frequency signal [5]. So that harmonics signals suppressing method is investigated. This paper presents the bandpass filter using two pieces of tapered-line resonators which are folded and add a slit into the side of each resonator. The tuning slit helps in pressing the harmonic frequency signals. The 2nd section will be described the design of the circuit that has the center frequency of 2.4 GHz. The 3rd section will be showed the simulated and measurement performances of the proposed structure and then compare together. Finally, the 4th section is a summary of the folded tapered-line resonators bandpass filter with tuning slits to eliminate harmonic frequency signals.

2. Design

In the designing of resonators, it is starting by studying in the bandpass filters that have presented in [5] which used 4 tapered-line resonators to casscade together. The response of the circuit has continuously produced harmonic frequency signals and its size was too large. First, 2 tapered-line resonators are taken for size reduction by designing the length of resonators is around a half wavelength ($L = \lambda g / 2$) of the desired frequency. In this case, the frequency of 2.4 GHz is applied and then casscade them with the electric coupling as shown in Figure 1(a). GML 1032 is the material for designing of the circuit, with the dielectric constant (ε_r) = 3.2 and a thickness (h) = 1.524 mm. The IE3D is the electromagnetic software to support the designing and optimization to



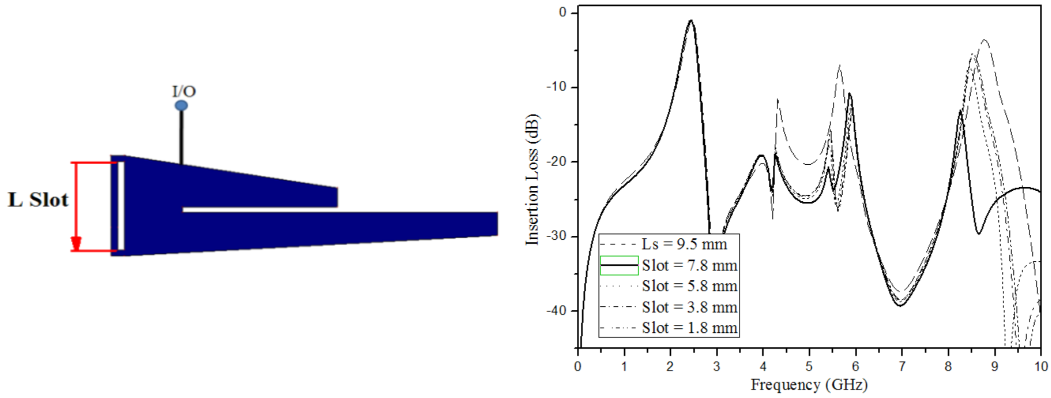
(a) (b)

(c)

Figure 1: The Folded Tapered-Line Resonators (a) Conventional Structure
(b) Asymmetrical Structure (c) The Responses When Modifying Ls.

maintain the width of the port impedance is 50 ohms and the gap of 0.5 mm. It found that the size of the filter can be reduced 50% of the original circuit at the center frequency response of 2.4 GHz. In this case, the harmonic frequency signals are still kept. Therefore, we have to adjust the value of Ls to have more space coupling and then it will be the tapered-line resonator with an asymmetric structure as shown in Figure 1(b). Figure 1(c) shows the simulation results. It can be noticed that the transmission coefficient (S_{21}) of the 1st harmonic frequency around 4.8 GHz will be compressed when the distance Ls is 9.5 mm and the bandwidth of the desire frequency is reduced 43.4%. The 2nd and the 3rd harmonic frequency are shifted and still high. Therefore, the study of the techniques to reduce the unwanted signals is desired.

The drilling slot at the resonator and adjusting the length of slots have been proposed for suppressing the harmonic frequency signals [6]. So, the applied slot is taken to the proposed asymmetry tapered-line resonator at the end of the side of each resonator as shown in figure 2(a). Figure 2(b) shows the responses of the transmission coefficient which the length of slot is varied. It found that the harmonic frequencies are reduced with the best response when the length of slot is 7.8 mm.

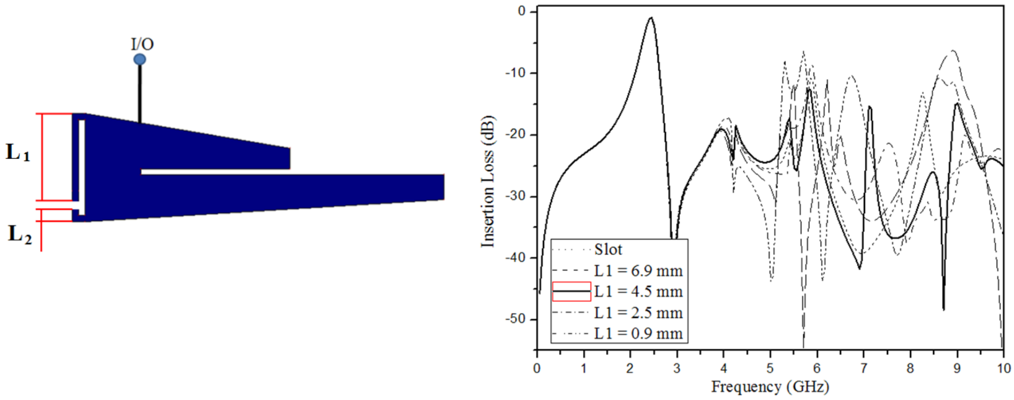


(a) (b)

Figure 2: (a) The Structural of Asymmetrical Folded Tapered-Line Resonator With Slot
(b) The responses When Modifying The Length of Slot.

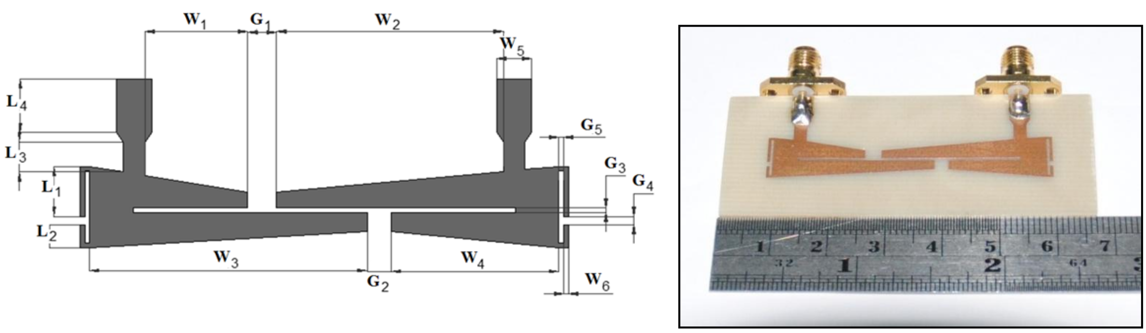
Besides, the adjusting slit has been suggested in order to eliminate the unused signals [7], so that it is also applied to the proposed resonator as shown in figure 3(a) which is classified the length of slits are L_1 and L_2 by making a gap between slits for getting rid of the harmonic frequency signals. The length of slits can be adjusted in the same time. From the simulation, to get the best responses of the transmission coefficient the length of slits L_1 = 4.5 mm and L_2 = 3.8 mm with the gap of 0.5 mm, as shown in Figure 3(b). The harmonics frequencies are directly affected with the slits because when slits are varied, at least two fundamental frequencies which are responded with them are changed. In the same way, their harmonics responses are also changed.

Figure 4(a) shows the layout of the proposed bandpass filter with the tuning slits. The optimized dimension are followings: L_1 = 4.5 mm, L_2 = 3.8 mm, L_3 = 3.63 mm, L_4 = 5.8 mm, W_1 = 10.77 mm, W_2 = 23.77 mm, W_3 = 29.09 mm, W_4 = 17.59 mm, W_5 = 3.66 mm, W_6 = 0.5 mm, G_1 = 3.0 mm, G_2 = 2.5 mm, G_3 = 0.5 mm, G_4 = 0.9 mm, and G_5 = 0.5 mm.



(a) (b)

Figure 3: (a) The Structural of Asymmetrical Folded Tapered-Line Resonator With Slot (b) The Responses When Modifying The Length of Slits.



(a) (b)

Figure 4: The Proposed Bandpass Filter (a) Its Geometry (b) Its Photograph.

3. The Fabricated Bandpass Filter

After the design of the proposed bandpass filter by the electromagnetic software simulation, the milling tool process fabricated the circuit as shown in figure 4(b). The structure of the filter is presented. After that, it is measured the characteristic responses that are the reflection and transmission coefficient and finally, they are compared with the simulated results as shown in figure 5. It can be observed that the simulated and measured desired frequencies are exactly produced at 2.4 GHz. The measured responses of the reflection and transmission coefficient are approximately -1.1 dB and -15.1 dB, respectively.

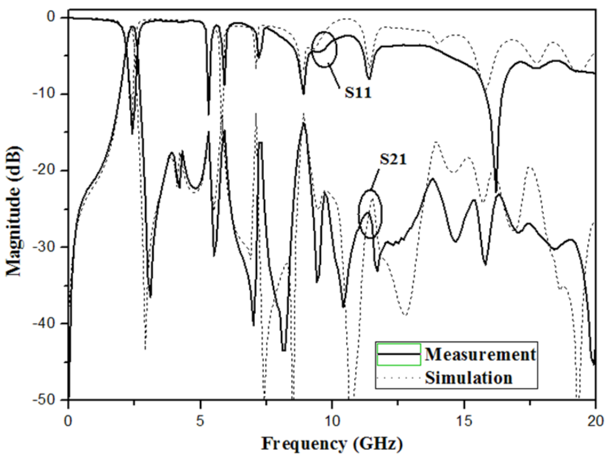


Figure 5: Comparisons of The Simulated and Measured Results.

4. Conclusion

This paper has been presented the asymmetrical folded tapered-line resonators bandpass filters with tuning slits which can be seen that when adding slits, the harmonic frequency signals will be compressed. Besides, the size of the proposed filter is 50% reduction when compared with the original one and the responses of which are agreed very well when compare with the simulation and can be accepted and applied for the wireless communication systems.

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