Asymmetric Stepped Impedance Resonator Based Dual-Band Bandpass Filter

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Abstract
A dual-band bandpass filter for WLAN application is presented in this paper. The proposed filter is realized using coupled asymmetric SIRs with 50 ohm I/O feed line. The center frequencies of the passbands are 2.4 GHz and 5.5 GHz, respectively. Miniaturization is obtained by folding the linear asymmetric SIR and coupling them and selectivity is produce by I/O feed line to create two transmission zeros. The passband insertion loss is within 2 dB.

Keywords
Asymmetric SIR, Dual-band bandpass filter.

I. Introduction

Band pass filters are indispensable component in a receiver front end. With the multi-band wireless systems witnessing prolific development, the demand for multifunctional circuits and components has increased. Today the bandpass filters (BPFs) have become more attractive and essential component in modern wireless communication systems in a variety of services, such as global positioning system (GPS), Bluetooth, and wireless local area network (WLAN) and demand an exact selection of wanted signals which is critical in these systems. Planar bandpass filters (BPFs) are preferred structures because they can be fabricated using printed circuit technology and are suitable for commercial applications due to their compact size and low cost of integration [1]. A plethora of techniques have been employed in design of multi-band BPF. It can be realized by using stepped impedance resonator (SIR), with the use of SIR or open loop resonators with stub and also by incorporating two sets of resonators of different sizes for different passbands. It is observed that SIRs, introduced by Makimoto and Yamashita [2], were used to achieve multiband filters. Concentric arrangement of UIR with enhanced coupling is used to design a dual mode dual-band BPF [3]. In [4] a pair of SIR with interdigital coupled line is realized to achieve compact size DB-BPF. Miniaturized dual-band bandpass filter can be achieved by used in reduced line parallel coupled line [5]. Moreover passbands do not have independently controlling and selectivity is poor at the lower band due to absence of transmission zero. Asymmetric stepped impedance resonators (ASIRs) with PIN diodes were used to independently control the passbands and achieve the dual-band also as reported in [6]. The transmission zeros not only can sharpen the passband skirts, but also enhances the stopband rejection. High selectivity in dual-band BPF can be achieved by using of asymmetric stub is presented in [7].

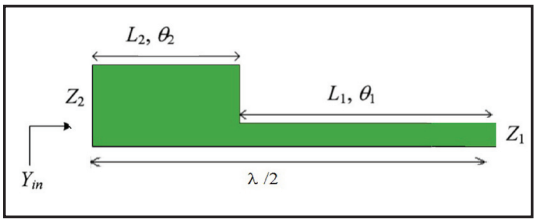


Fig. 1: Schematic of the Proposed an Asymmetric Stepped Impedance Resonator

In this work an asymmetric Sir as shown in Fig. 1 is designed to create two passbands at 2.4 GHz and 5.25 GHz, respectively. The structure is novel from simplicity viewpoint as the presented design is compact and easily replicable.

II. Design and Characterization of ASIR

The initial design is a half-wavelength (λ/2) asymmetric SIR as indicated in Fig. 1. The resonator is composed of high impedance (Z_1) section of electrical length (θ_1) followed by low impedance (Z_2) section with electrical length (θ_2), respectively. The input admittance for the asymmetric SIR can be calculated as

$$Y_{in} = -jY_1 \frac{K\tan\theta_1 + \tan\theta_2}{\tan\theta_1 \tan\theta_2 - K} \quad (1)$$

The characteristic impedance ratio 'K' and the length ratio 'u' of an ASIR are defined as follows

$$K = \frac{Z_2}{Z_1} \quad (2)$$

$$u = \frac{\theta_2}{\theta_1 + \theta_2} \quad (3)$$

The condition for the fundamental resonance of an ASIR can be derived by equating Y_{in}=0. A series of parametric studies by varying K and u have been accomplished to identify the resonance behavior of the proposed topology of dual band bandpass filter using ASIR. The usable design was found to posses K=0.72 and u=0.64 which was determined after fine tuning the pass band frequencies as per the specifications. The resonance characteristic of the asymmetric SIR as shown in Fig. 2 is obtained by loosely coupling the resonator to the 50Ω I/O port.

III. Filter Design

The ASIR is bent in a closed loop and the two sections are coupled together along the low impedance section as shown in fig. 3. The design is realized on Taconic TLY-5 substrate with a thickness of 0.787 mm and relative dielectric constant of 2.2. The I/O coupling is realized by the 50Ω tap line. The most sensitive parameters that drastically influenced the filter passband response are the inter resonator gap 'g' that directly influence the coupling between the

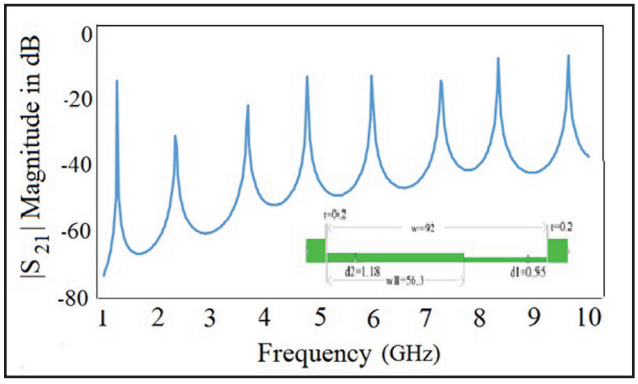


Fig. 2: Resonance modes of an asymmetric SIR

resonator and the spacing 's' between high impedance section of ASIR and the 50Ω high impedance section as indicated in Fig. 3. A gaping of 0.2 is found to be optimum in achieving desired passbands. Here s=0.15 mm value is selected for the best response of the proposed DB BPF. The I/O coupling is ensured to extract the resonance modes from the ASIR.

IV. Results and Discussion

The frequency response is obtained from SONNET Professional v.13.52 software. The S-parameters of the proposed filter is shown in Fig. 4. The center frequencies of the two passbands are 2.4 GHz and 5.25 GHz. The insertion loss of the two passband is within 1.25 dB. Here two transmission zeros are achieve at 1.8 GHz and 4.2 GHz, respectively due to source load coupling.

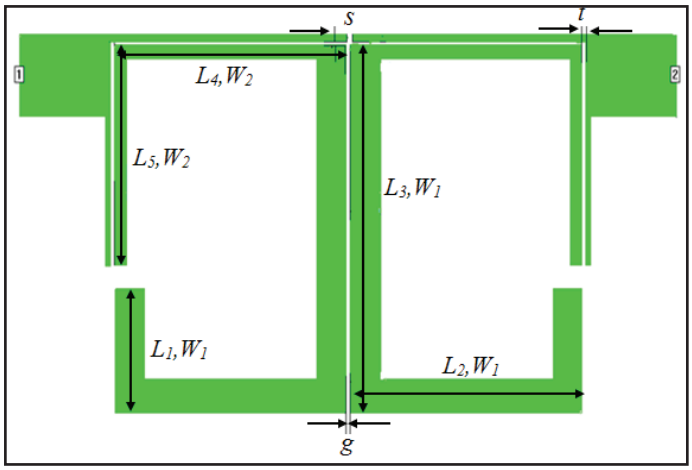


Fig. 3: Layout of the Proposed an Asymmetric Based Dual Band BP With L_1=4.72, L_2=10.2, L_3=14.03, L_4=10.24, L_5=8.39, W_1=1.18, W_2=0.55, g=0.2, s=0.15 and t=0.2 (all are in mm).

V. Conclusion

This paper reports some initial findings on the dual band tuning property of asymmetric stepped impedance resonators. This is demonstrated with a dual band bandpass filter with passbands at 2.4 GHz and 5.25 GHz respectively. The insertion loss of each passband is within 1.25 dB. Two transmission zeros at 1.8 GHz and 4.2 GHz are obtained.

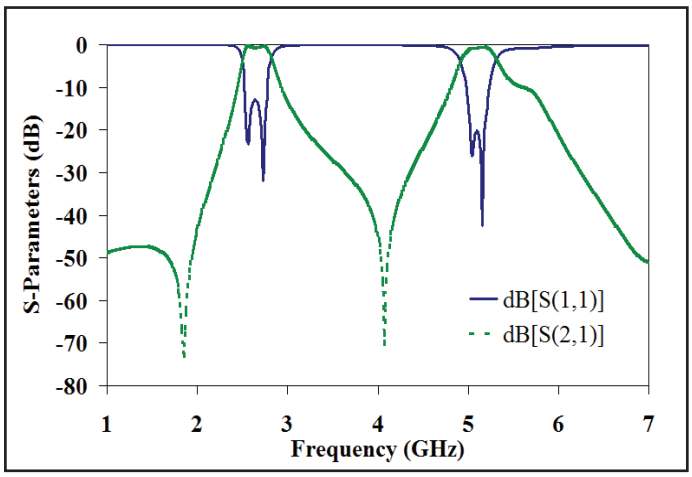


Fig. 4: Plot of S_{11} and S_{21} Characteristic of the Proposed Dual Band BPF

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