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Design of Bandpass Filter Based on Asymmetrical T-shaped Resonators

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Abstract

Two different T-shared resonators are used for the proposed bandpass filter with wide rejection band. Each resonator is considered with dissimilar impedance and electrical length because of the harmonics resonant response generating with difference positions. All theoretical and experimental results are verifying this concept at the fundamental frequency 2.45 GHz. The insertion loss is 2.74 dB and the return loss is 21.95 dB respectively. The levels of stopband are lower than 25 dB up to 20 GHz.

Keywords: bandpass filter; T-shaped resonator; harmonic suppression; hook feed line

1. Introduction

A novel compact microwave bandpass filter with high selectivity, wide stopband and small insertion loss is a good performance demanding in front end of wireless local area network [1]. There are a lot of resonator structures for proposing bandpass filter. A T-shaped resonator is one of favorite structures to be used. A dual-band bandpass filter using folded T-shaped half-wavelength resonator is proposed in [2].With capacitive load coupling for feeding and multiple transmission zeros are generated, although not good for the second band bandwidth is produced.The authors in [3] presented the technique to obtain extremely sharp skirt by using T-shaped resonators combine with

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high and low-impedance lossless line lowpass and U-shaped suppressing cells.On the other hand, defected ground structure (DGS) is applied to etch a microstrip line ground has a main advantage for providing high capacitive coupling [5].

In this paper, the bandpass filter with difference asymmetrical T-shaped resonators and hook feed-lines are proposed as the fundamental concept which issimilar to [6] but improved the internal coupling by folded T-shaped resonator. With the asymmetrical structures, the wide rejection band is observed. To validate the results, a proposed bandpass filter is designed and fabricated.

2. Design

T-shaped structure resonator is selected to design the presented bandpass filter with wide harmonics suppression because it is a modified of step-impedance resonator (SIR) so that it is flexible to adjust the harmonics response shifting. As present in [6], the resonant equation is analyzed from the impedance and electrical length structures are shown in Fig 1(a), which is composed of equation (1) and equation (2).

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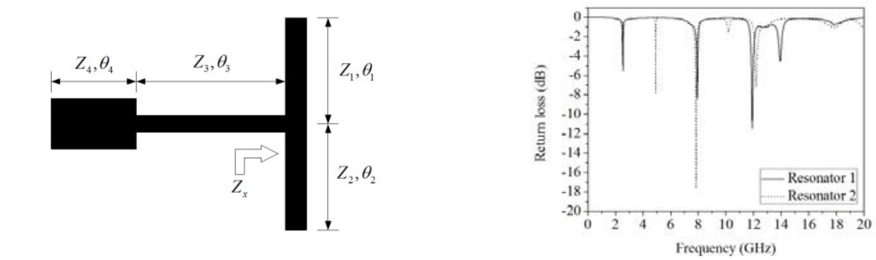
$$Z_x = \frac{Z_1 Z_2 \cot\theta_1 \cot\theta_2}{Z_1 \cot\theta_1 + Z_2 \cot\theta_2} \quad (1)$$

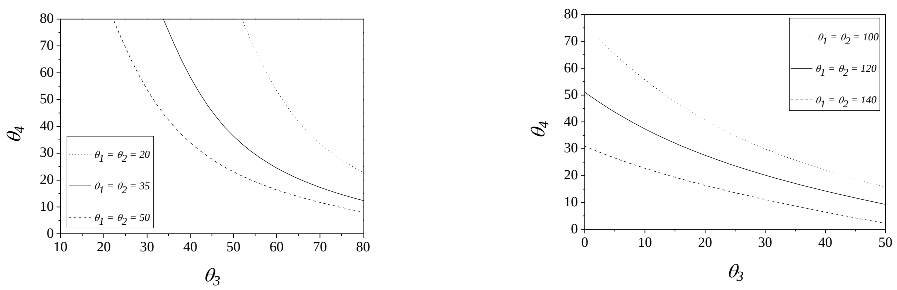
$$Z_3 Z_4 + Z_4 Z_x \tan\theta_3 + Z_3 Z_x \tan\theta_4 - Z_3^2 \tan\theta_3 \tan\theta_4 = 0 \quad (2)$$

The different T-shaped resonators are intended and also produced in different frequency response as shown in Fig.1(b). It is noticed that the both resonators generated the same fundamental frequency of 2.45 GHz, which are calculated from equation (2), but they produced in different of harmonics frequencies so that they could eliminate the unwanted signals by themselves as shown in Fig.1(b).



(a) (b)

Fig. 1. (a) Basic structure of T-shaped resonator (b) The frequency responses of two T-shaped resonators



(a) (b)

Fig. 2. The calculated electrical length of θ_3 versus θ_4 (a) the first resonator (b) the second resonator