Dual-Band Bandpass Filter using Assembled Resonators for WLAN and RFID Application

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ABSTRACT

A dual band bandpass filter for WLAN and RFID application is presented in this paper. The proposed filter is realized using asymmetric fed intercoupled open loop resonators (OLR) with embedded E-shaped resonators with open stubs. The center frequencies of the passbands are 2.45 GHz and 6.8 GHz. The insertion loss at each passband is on average within 2 dB. Four transmission zeros are obtained of each pass band for high selectivity. The stop band attenuation is below 10 dB with the band extending up to 10 GHz. The overall size is 28 mm by 15.25 mm which brings about considerable miniaturization.

1. INTRODUCTION

In modern wireless communication systems, the dual band bandpass filter (BPF) has been widely investigated, because it is a key component in many RF wireless system frontend. Recently, several types of dualband BPFs with dual mode operation have been developed that use microstrip open loop resonators [1]. Planar band pass filters (BPF) are particularly popular 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]. There are three broad categories of dualband filter design [2]. First one is to utilize dual-mode stepped-impedance resonators (SIRs) [3]. Second method is multilayer technology, which is based on two dual mode resonators to design the dual mode dual band BPFs [4-5]. Third category represents a class of dual-band filter design based upon the stub is connected to the E-shaped resonators using SIR. In [6] a new dual-band BPF is designed using the E-shaped resonators which provide the higher frequency passband with the transmission zero for high selectivity.

In this paper half wavelength uniform impedance resonators (UIR) with E-shaped SIR and loaded with open stub is utilized to generate two passbands at 2.45GHz and 6.8 GHz. The asymmetric feeding and inter resonator coupling inherently brings about transmission zeros necessary for improving filter selectivity.

2. FILTER DESIGN AND PARAMETRIC STUDY

The layout of the proposed filter is illustrated in Fig. 1. It consists of two outer open loop resonators and two E shaped resonators. Each E-shaped resonator is composed of hairpin shaped stepped impedance resonators loaded by an open stub at the centre. The proposed filter is realized using dielectric substrate of dielectric constant 2.2 and height of 0.787 mm.

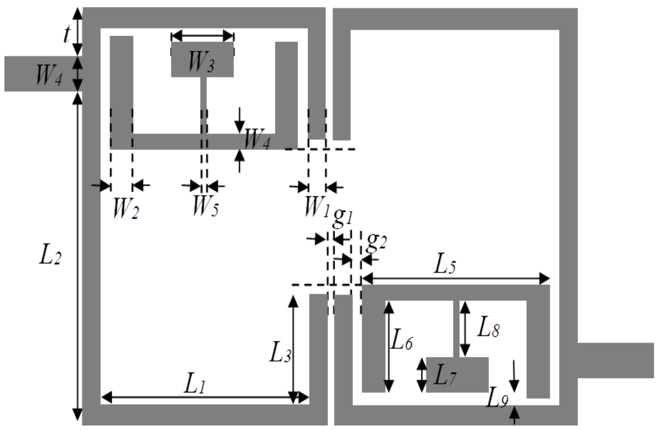
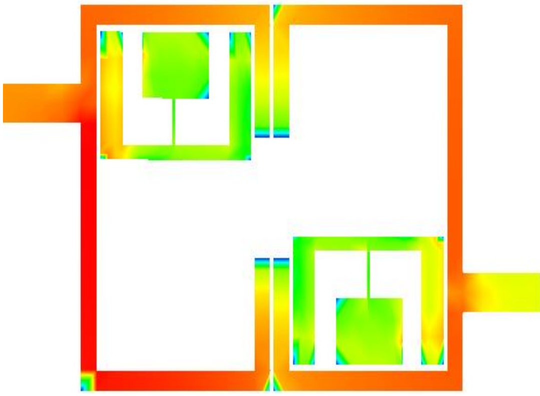
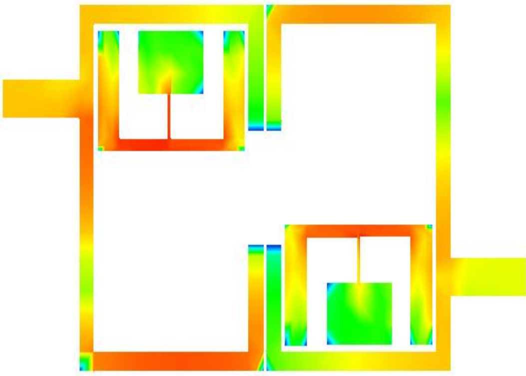


Fig 1: Layout of the proposed dualband bandpass filter

For all numerical analysis of the proposed planar filter commercially available method of moment simulation software IE3D™ is used. The dual pass passband is achieved at the desired frequency for the combination of the open loop resonators and the E-shaped resonators. The current distribution as shown in Fig. 2 gives insight in to the operation of the proposed dual band BPF. Source load coupling introduces desirable transmission zeroes that improves the selectivity of passbands. The outer OLR is designed to be half wavelength at 2.45 GHz. The E-shaped resonator is designed to address the second band. The tapping point is determined by well established techniques [1].



(a)



(b)

Fig. 2 Normalized electric current distribution on the filter at (a) 2.45 GHz, (b) 6.8 GHz.

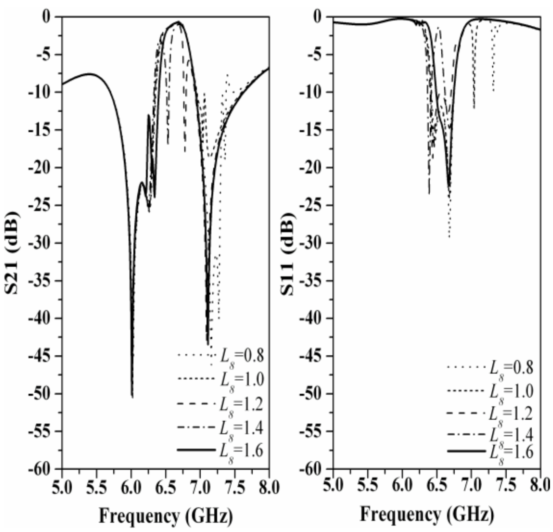


Fig. 3 Influence on transmission characteristics due to open stub length.

The first parametric study on the proposed filter is performed by varying the stub length L_8. Changing the stub length tunes the upper pass band frequency as shown in Fig. 3. The optimum value of L_8 is found to be 1.6 mm. The next parameter under study is the position of the two embedded E shaped resonators denoted by L_9 as indicated in Fig. 1 which is desirable to achieve the transmission zero at 7.2 GHz. If the gap of this resonator is decreased then the transmission zero is

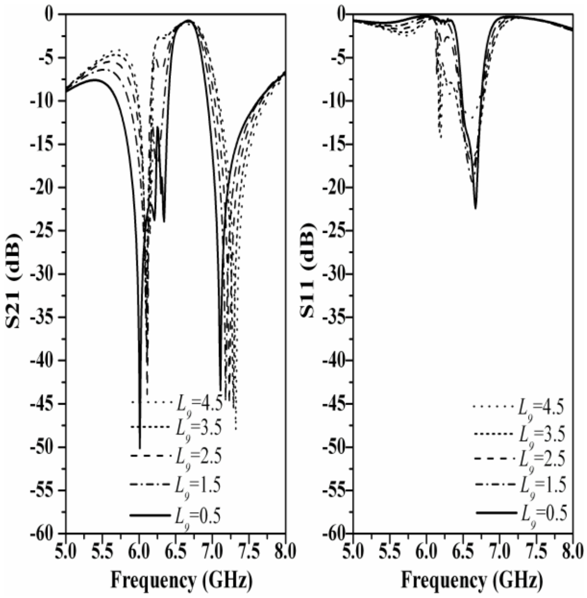


Fig. 4 Influence on transmission characteristics due to open stub length in the input port.

shifted towards the higher frequency. The suitable value for L_9 is 0.5 mm.The overall dimension of the BPF is 28 mm by 15.25 mm which brings sufficient miniaturization for proper packaging inside a transceiver.

3. RESULTS AND DISCUSSION

The proposed filter is realized using dielectric substrate with dielectric constant of 2.2 and height of 0.787 mm. The final s-parameters of the dual band BPF is shown in Fig. 5.

TABLE 1 DIMENSIONS OF DUAL-BAND BANDPASS FILTER

Parameters	Dimension (mm)
L_1	8.00
L_2	10.44
L_3	4.29
L_5	7.65
L_6	4.40
L_7	2.64
L_8	1.60
L_9	0.50
t	3.00
W_1	0.83
W_2	1.20
W_3	2.64
W_4	1.54
W_5	0.17
W_6	0.50
g_1	0.30
g_2	0.20

The insertion loss at passband is within 2 dB. Here four transmission zeros are achieved which are present in 2.3 GHz, 3.2 GHz, 6.1 GHz and 7.2 GHz. Due to source load coupling the stop band performance of this dual band filter is satisfactory with the stop band extending up to 10 GHz. The center frequency of passband is 2.45 GHz and 6.8 GHz. The optimized dimensions of filter parameters are tabulated in table 1. The overall dimension of the developed BPF is 28 mm by 15.25 mm, which results in a compact size.

It reveals that the outer resonator contributes to the 2.45 GHz band as displayed in Fig. 2 (a). The current distribution pertaining to the RFID band of 6.8 GHz is observed in the inner E-shaped resonators, which is nearly half wave length, is shown in Fig. 2(b). An I/O coupling is ensured by a 50Ω tap line that is connected to the outer resonator. The position of the tapping point is 3 mm as denoted by the length'*t*' in the Fig. 1. This tapping point is determined by well established technique of extracting the external quality factor [1] and fixing the position of the tap line to ensure maximum energy coupled out of the resonator arrangement. The Table 1 represents the exact dimensions of the proposed filter. The mutual coupling is based on the lateral separation of the two resonators that determine the energy coupled from one to the other.

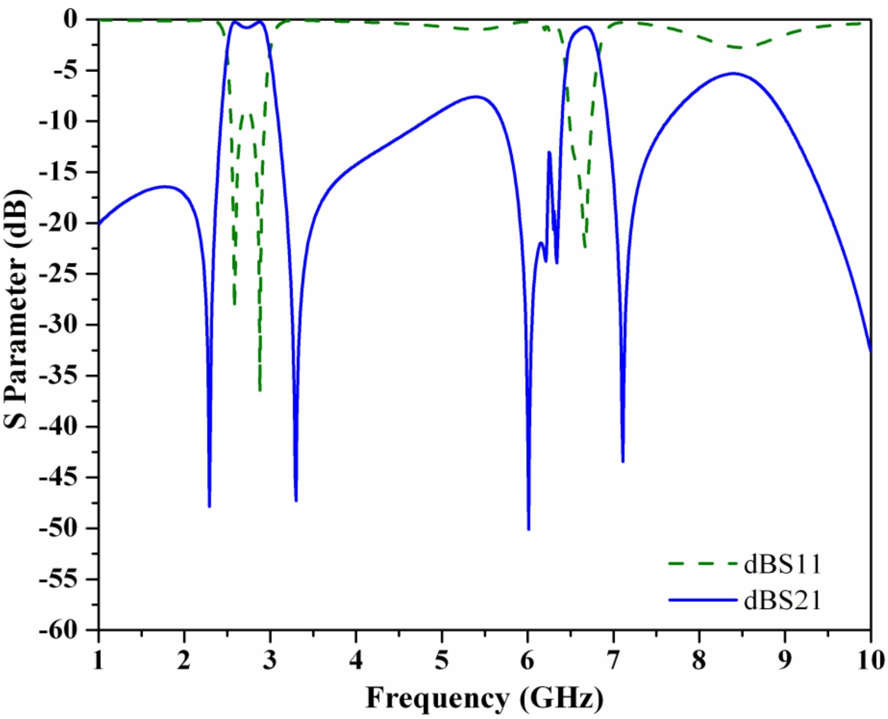


Fig. 5 Plot of S11 and S21 characteristic of the designed dual bandpass filter.

4. CONCLUSION

The paper presents a novel design of a dual band bandpass filter using a simple design with open loop resonator and E shape resonators. The center frequency of the passband is at 2.45 GHz and 6.8 GHz with insertion loss within 2dB at each band. The overall dimension of the filter is 28mm by 15.25mm.

5. REFERENCES

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