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Design of a Microstrip Quad band Bandpass Filter Using Intercoupled Resonator with Centre Loaded

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ABSTRACT

A compact micro-strip band pass filter with quad band is proposed in this paper. It consist four resonators and excited by coupled line section. One resonator excites next and continues to generate four bands. These four frequencies are independently control. Here idea is stub is loaded at loading point where voltage is zero. This filter is tuned to desire frequent by simple modification of its length. The insertion loss of the shown filter is less than 1.3 dB and return loss is below 12dB. Presented filter is compact size of 0.17λgx0.13λg .The filter is imitated with commercially available tool ADS and outcome were compared and demarcated with previously reported results.

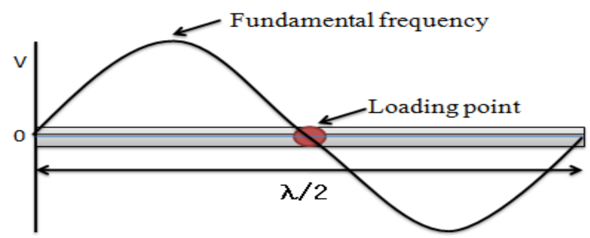
Keywords—Bandpass filters; Quad-band;

I. INTRODUCTION

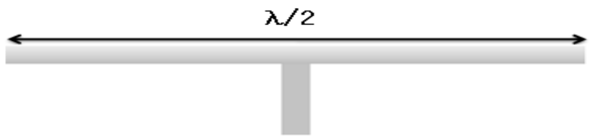
WITH the development of wireless communication system, Demand of quad band filter has been increases. Some application such as GSM, Bluetooth ,Wi-Fi systems and etc have been used in a single device, But these application works on different frequency band. Therefore to support these application different filter has used. This increased the complexity of system. To reduce complexity of system should be design to work on different band of frequency on a single device. Many multiband band pass filter has been released since recent year [1]. Various method and structure are being used to confine the Spectrum in one single device. Most common method to design multiband is by using step impedance resonator [2]-[5], these filter based on Step impedance. In MMR frequencies are decided by properly maintain the ratio between the impedance of structure. But complexity and size problem was still in picture.

Coupled line and ring resonator is also used to design multiband band pass [6]-[7]. In coupled line section frequency is resonate and maintain by coupled line section. In ring resonator frequency is resonate on the basis of length of ring resonator. Different frequency is tuned by adjusting coupled line section and length of ring resonator. But in both only two and three band BPF is previously reported.

In this paper, a new resonator based quad-band band pass filter is proposed. This structure is simple and via free so easy to fabricate. In this structure, We use properties of both coupled line section and ring resonator. Coupled line section is used to excite outer resonator and that will excite next resonator and so on. This resonator is loaded at a loaded point where voltage is zero as shown in Fig.1(a) [9].An open stub is loaded at loading point as shown in Fig1.(b) [9]. Therefor resulted structure add respective frequency and it does not disturbed previous resonated frequency. The design has a flexibility to shift frequencies range by changing the coupled line sections and by changing length of ring resonator. The filter is realized on a low cast Rogers TMM substrate with a relative dielectric constant of 10.2 and thickness 1 mm. Generated frequencies are 1.9,2.4,3.9 and 5.4 GHz. The size of proposed Quad band BPF is about $0.17\lambda_g x 0.13\lambda_g$.. The electromagnetic simulation of designed filter is carried out with the use of commercially available tool ADS [8].Filter design and analyses are presented and verified by ADS.



(a)



(b)

Fig.1 loction of loading point (a) Voltage distribution of λg/2 open stub (b) Open stub is loaded at loading point [9]

II.PROPOSED QUAD-BAND FILTER

Fig2. Shows the configuration of proposed filter with their dimension notation. It consist three ring resonator and one coupled line section. Outer part of filter is half wave length of resonating frequency, is excited by feed coupled line section. That will excited in inner loaded ring resonator which resonate at resonate frequency of respective length. Same process is again done and continues. Here three resonator is resonate three different frequency. Two frequencies is resonated by outermost coupled line section. Therefore, there are five resonated frequencies. But Out of five frequencies two frequencies is so close to each other so one band is formed. Finally quad band is obtained. Because of simple and via free structure, it is easy to fabricate. Structure of proposed quad band filter is shown in fig.2

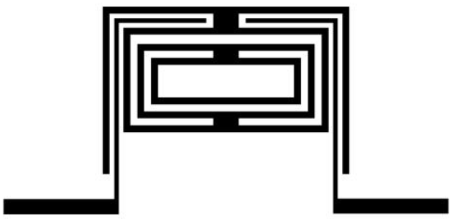


Fig 2. Schematic of the quad band filter.

Substrate: Er=10.2, thickness=1mm.

Using a commercially available tool [8], filter structure is analyzed. Step by step construction of quad band filter is explained below. Fig3. (a) Is analyzed for resonating structure. Resonator of half wavelength is excited by

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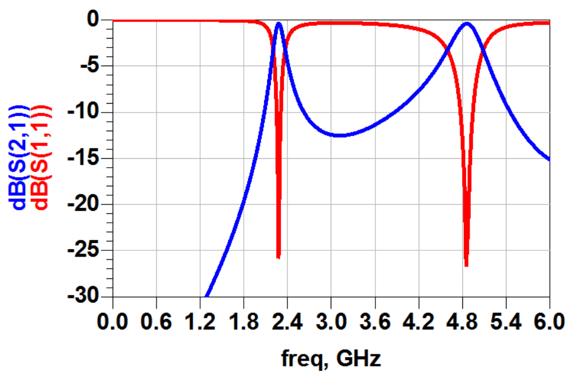
coupled line section. Due to quarter wavelength of coupled line section two frequency is generated as shown in Fig3. (b).This structure is resonated at 3.8 and 5 GHz.

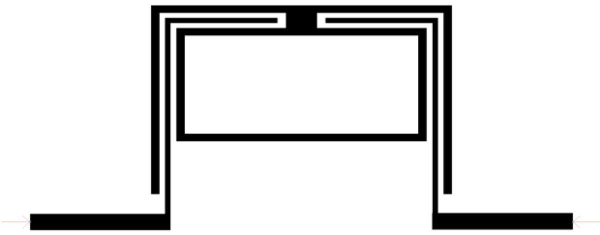
(a)



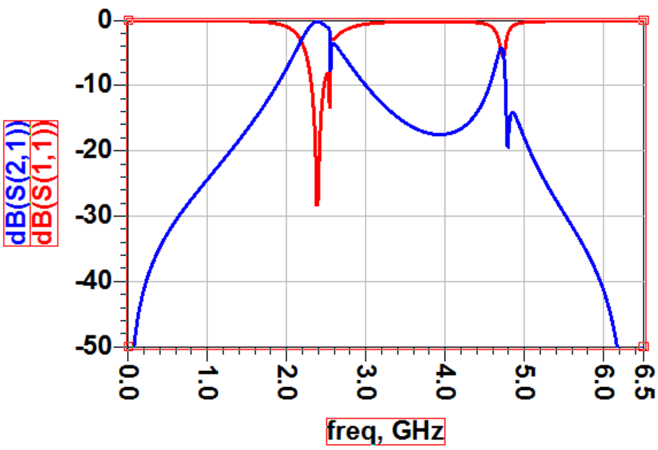
(b)

Fig 3. Proposed resonating structures without loaded resonator (a) Design of resonator, (b) S_{11} (Return loss) and S_{21} parameter

In above structure voltage of resonating frequency is zero at center part of λg/2. This point is loading point. If any stub is loaded at this point one extra frequency is resonated and that will not disturb the previously resonated frequency. With this idea we add one ring resonator of half wave length λg/2 as shown in Fig.4(a). Three frequencies is generated but with shifted location due to coupling effect. These location can be adjusted by maintain the length of structure. S_{11} and S_{21} parameter of Fig4(a) is shown in Fig 4(b). First two frequencies is so close two each other that it will create a band.



(a)

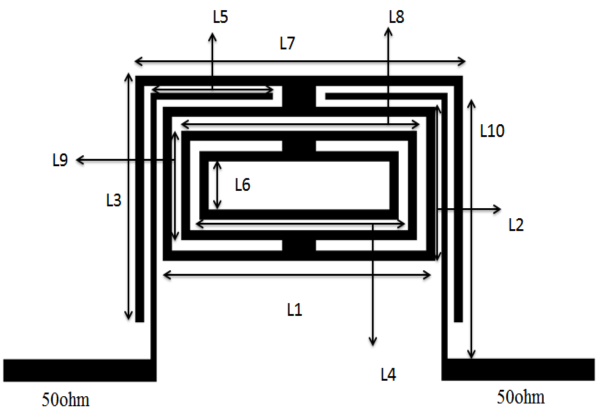


(b)

Fig 4. Proposed resonating structures without loaded resonator (a) Design of resonator, (b) S_{11} (Return loss) and S_{21} parameter.

For Quad band filter remaining two ring resonator is add at respective loading point as shown in Fig5.(a) Because of two resonator, Two other frequency is generated and that will not disturb the previous resonate frequencies. S11 and S21 parameter of Fig 5(a) is shown in Fig5 (b).

As in Fig5 (b) total five frequencies are resonated, three due to ring resonator and two due to quarter wave length coupled line section. But out of five frequencies two frequencies are so close that, it will create one band. There in final total four frequencies is resonated. So called quad band filter. These resulting frequencies location can be adjust by adjusting their length.



(a)

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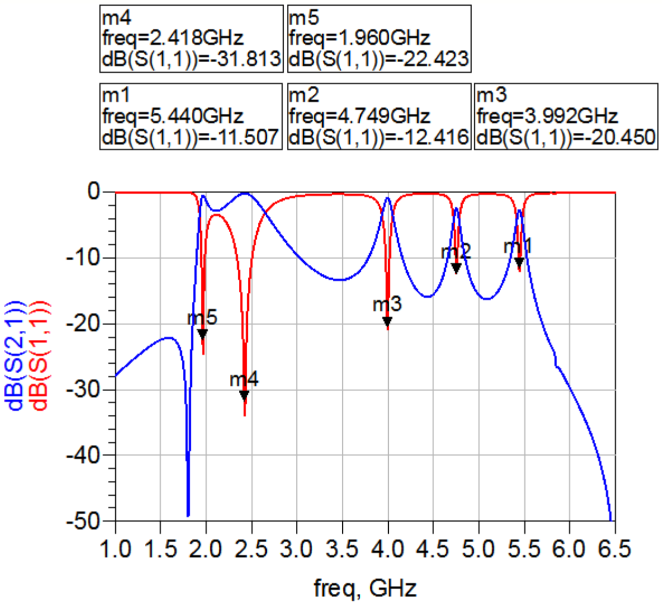

(b)

Fig 5. Proposed Quad band filter (a) Design of resonator, (b) S_{11} (Return loss) and S_{21} parameter

Dimension for design filter are given below in Table.1,

TABLE.1

S.N.	DIMENTIONS OF FILTER		
	Symbol	***Length***	***Unit***
1.	L1	8.9	mm
2.	L2	4.5	mm
3.	L3	7.5	mm
4.	L4	6.5	mm
5.	L5	4.0	mm
6.	L6	1.4	mm
7.	L7	10.7	mm
8.	L8	7.7	mm
9.	L9	3.2	mm
10.	L10	7.6	mm
11.	W1	0.2	mm
12.	W2	0.3	mm

All dimensions are in mm, and the center frequency is considered to 4.0 GHz. Width of the bigger strip is 0.3mm and smaller one has 0.2mm.Characteristic impedance of filter at input and output port is 50 ohm and the length is such that the ports resonating frequency does not disturb other required resonating frequencies. Filter is made up of the substrate material named ROGER which has the relative dielectric constant of 10.2 and thickness 1.6mm.

ADS is the tool used for verifying the system virtually.

This proposed quad band filter has, Insertion loss is below to -1.3dB and return loss is about 12 dB. Overall size of the filter is 0.17 λg x0.13 λg at center frequency 4.0 GHz.

III.PERFORMANCES

Proposed filter is design for four frequency range. Filter is having two ring resonators for their respected frequencies.it provides four different frequencies in one device which can be used as required and at the same time it is very compact in size. Now a days there are so many work for the system which provides more than one frequency in one device.Table2 gives the overview of the performance comparison of proposed filter with recent published filter.

TABLE.2 PERFORMANCE OF QUAD BAND BANDPASS FILTER WITH PROPOSED FILTER

Ref.	Pass bands	Insertion Loss (dB)	Return loss (dB)	Filter Size(λg× λg) (mm²)
[11]	2.4/3.5/5.2/6.8	0.5/1.3 1.3/1	13/38 19/26	480 (0.3×0.3)
[12]	0.9/1.26/1.89/2.2	2.2/2.1 1.4/0.9	23/23 25/30	2401 (0.5×0.5)
[13]	1.57/2.45/3.5/5.2	0.3/0.3 0.3/0.8	30/19.4 19.4/12	263 (3.2×1.1)
[14]	1.5/5.2/3.5/5.5	2.6/2.1 2.9/2.0	12/16 15/14	802 (0.2×.18)
My work	**1.9/2.4/3.9/5.4**	**1.3**	**12**	**88 (0.17×0.13)**

In table 2 shows that the proposed filter has the size of 88mm² (0.17 λg ×0.13 λg) which is smaller than all the other. It has the insertion loss below 1.3dB and return loss below 12dB.

IV.CONCLUSION

A quad band band pass filter using intercoupled resonator is designed which can provide four different frequency for different applications by tuning the length of resonator also this filter has a very small insertion and return loss. This filter has very small size in comparison to other earlier reported quad band filter.

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