Design and Analysis of S Parameters for Tri-Band Band Pass Filter

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Abstract - In this study, a tri-band band pass filter was built using a multi-mode stub loaded resonator. The pass band has three frequencies: 0.92, 2.08, and 3.59 GHz. Open stubs were coupled together to provide a triple pass band pass filter while also condensing the circuit footprint. A pass band has been constructed with insertion losses of 0.41, 1.39, and 1.97 db and return losses of over 27.7, 12.3, and 16.2 db, respectively.

Keywords –tri-bandfilter,insertionloss,returnloss.

I.INTRODUCTION

The Tri-bandbandpassfilter BPF is one of the key frontend elements of multiband wireless communication systems. In order to meet the need, further studies on dualortri-bandbandpassfilters[1–9] have been published. [1.] describes dual-band bandpass filters using stub-loaded resonators. A Tri-band response may be produced by combining openstubs with DGSin[2]. Three pairs of degradation modes are used to characterise a tri-band response from a single ring resonator in [3]. On the other side, the passband locations are not reachable in this way. The employment of several resonators in these topologies leads to larger circuit sizes, despite the fact that passband frequencies may be individually modified using SLRs in[4-6]. The additional loaded stubs are provided with simple controllability of each passband in order to create the tri-band filter[7]. Unique resonators were employed to create tri-band feedbacks in [8],[9]. Many intriguing methods for creating balanced multi-band filters have been developed, including the stepped-impedance resonator (SIR) [10], stubloaded resonator [11], coupled-step-impedance resonator [12], and asymmetrical coupled lines [13]. This is because balanced filters can offer greater immunity in noisy environments. Even so, it's possible that the common-mode suppression of these balanced filters is inadequate, necessitating the addition of a lumpedelement to increase common-mode suppression between resonators. On the basis of earlier works[1],[11], a tub-loaded resonator with multiple mode characteristics to achieve triple-band BPFi is described here. The even-odd-mode technique is employed to investigate its resonance properties. With the use of even-odd-mode analysis and EM full-wave simulations, the attitude of the whole passband may be seen. Theresonatoraswellastheloadedstubsarebenttogeneratetransmissionzerotoacquirepeakskirtselectively. Tri-band BPField technology was created and is currently in use. Sustained results show higher confirmation when compared to simulated findings..

II. RESONATORANALYSIS

Figure 1 depicts the real SLR, which has four open stubs and a stub that has been sorted (a). Use the even- and odd-modes to determine if any symmetrical instructures exist..

$$Y_{in,\ odd1} = \frac{Y1}{j\tan(\theta 1+\theta 3+\theta 5)} \quad (1)$$

$$f_{odd1} = \frac{(2n-1)c}{4(L1+L3+L5)\sqrt{\varepsilon e}} \quad (2)$$

$$Y_{in,even1} = -jY1\frac{Ys-2Y1\tan(\theta 1+\theta 3+\theta 5)\tan\theta 5}{2Y1\tan(\theta 5)+Ys\tan(\theta 1+\theta 3+\theta 5)} \quad (3)$$

$$f_{even1} = \frac{(2n-1)c}{4(L1+L3+L5+Ls)\sqrt{\varepsilon e}} \quad (4)$$

$$Y_{in,odd2} = jY_2\frac{Y1-Y2\tan\theta 2\tan(\theta 3+\theta 5)}{Y2\tan(\theta 3+\theta 5)+Y1\tan\theta 2} \quad (5)$$

$$f_{odd2} = \frac{(2n-1)c}{4(L2+L3+L5)\sqrt{\varepsilon e}} \quad (6)$$

$$Y_{in,even2} = -jY2\frac{Y1-Y2\tan\theta 2\tan\theta(\theta 3+\theta 5+\theta s)}{Y2\tan(\theta 3+\theta 5+\theta s)+Y1\tan\theta 2} \quad (7)$$

$$f_{even2} = \frac{(2n-1)c}{4(L1+L3+L5+Ls)\sqrt{\varepsilon e}} \quad (8)$$

$$Y_{in,odd3} = -jY_4\frac{Y1-Y4\tan\theta 4\tan\theta 5}{Y4\tan\theta 5+Y1\tan\theta 4} \quad (9)$$

$$f_{odd} = \frac{(2n-1)c}{4(L4+L5)\sqrt{\varepsilon e}} \quad (10)$$

$$Y_{in,even3}=-jY4\frac{Y1-Y4\tan\theta 4\tan(\theta 5+\theta s)}{Y4\tan(\theta 5+\theta s)+Y1\tan\theta 4} \quad (11)$$

and

$$f_{even}=\frac{(2n-1)c}{4(L4+L5+Ls)\sqrt{\varepsilon e}} \quad (12)$$

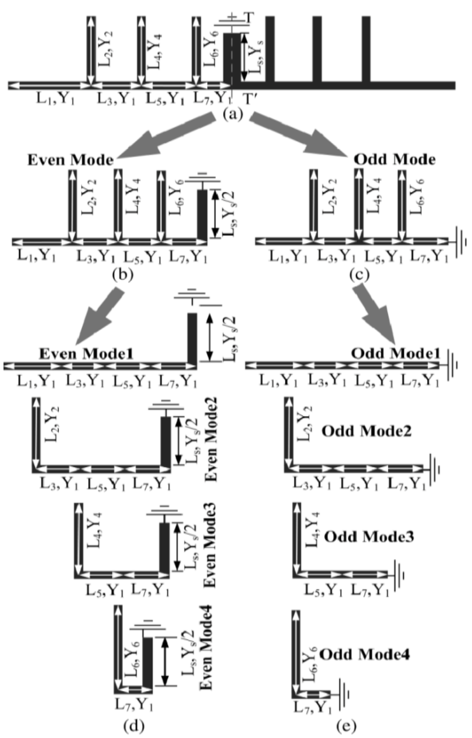

Figure 2.1 Equivalent Circuit

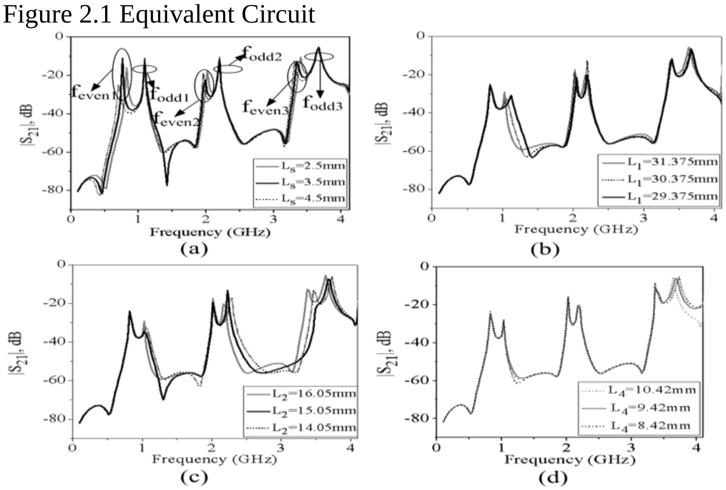

Figure 2.2 Return Loss of SLR

It has been shown that the equation (1) - (12) is only correct when there is no connection or a weak coupling. As a result, the equations are not strictly lasted, and precise parameter adjustments are needed when high coupling is encountered. Figure 2 displays the impact of various factors on the even/odd-mode resonance frequencies. The graphic demonstrates that Ls has no effect on odd-mode resonance frequencies. The first two even-mode resonance frequencies are unaffected by L1, the first two even-mode resonance frequencies are unaffected by L2, and the first two odd-mode resonance frequencies are unaffected by L4.

III. FILTER DESIGN

Based on the assessment indicated above, a tri-band BPF is created by tapping a stub-loaded resonator (SLR) with five microstrip transmission lines into a common through hole, as illustrated in Figure 3. On the other hand, the pass bands were located by varying the lengths and widths of each individual stub. The open stubs are independently linked to achieve the smallest circuit size and transmit zeros in the stop band. The filter was created using a Rogers RO4350 substrate with a width of 0.762 mm, a relative dielectric constant of 3.66, and a loss tangent of 0.004. The tri-band filter response is optimised through simulations using the 3D full-wave programme ANSYS HFSS v14.

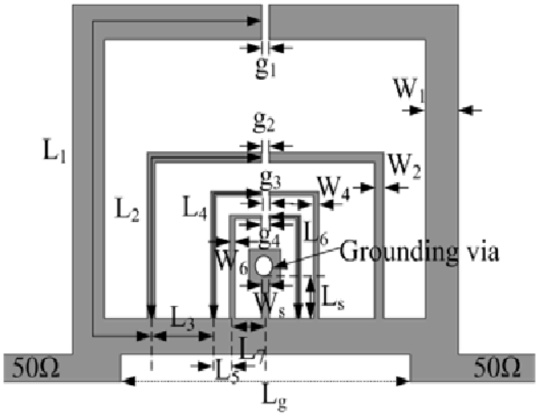

Figure3. Triband BPF.

IV.RESULT AND DISCUSSION

The BPF of this proposed tri-band is examined using a Key sight PNA N5221A network analyzer. A picture of the built-in filter may be seen in Figure 4. The proposed tri-band BPF has a total area of 30 mm2 and a weight of 0.14 g or 0.17 g, where g is the guided wavelength at the centre frequency of the lowest pass band..

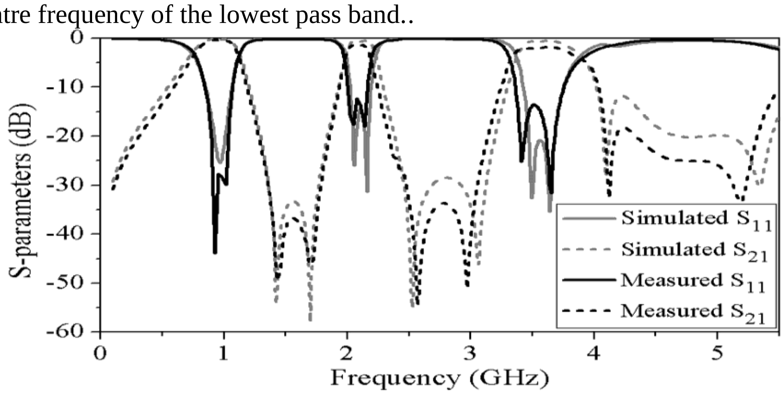

Figure.4. Proposed tri-band BPF.

Above the useful frequency range, the measured outputs logically concur with the predicted output, as seen in Figure 5. The three pass bands have 3dB split bandwidths of 40.21 percent, 10.1 percent, and 16.15 percent, respectively, and are oriented at frequencies of 0.92, 2.08, and 3.59 GHz. In the three pass band of the tri-band BPF, the estimated insertion losses (IL) and losses from two SMA connections are 0.41, 1.39, and 1.97 dB, respectively. The corresponding individual return losses exceed 27.7, 12.3, and 16.2 dB. In order to improve acute band-to-band rejection, six transmission zeros with attenuations of more than 30 dB have been found at 1.43, 1.69, 2.57, 2.97, 4.12, and 5.19 GHz. TABLE I contrasts the proposed tri-band BPF presentation with a few tri-band BPF presentations that have been published earlier and recently..

Table 4.1.Comparison of the Proposed Filter

Ref.	Frequency (GHz)	Circuit Size	TZs	3dB FBW (%)	IL (dB)
2	2.45/3.5/ 5.25	0.39×0.47	0	12.3/6.2/3.3	0.9/1.7/2.1
5	1.37/2.43/ 3.53	0.26×0.13	4	4.4/5.9/2.7	1.7/1.8/ 2.5
6	1.59/3.12/ 4.02	0.28×0.12	5	15.7/12.7/ 5.71	1.08/1.43/ 1.83
8	3.48/4.18/ 5.52	0.21×0.11	5	7/5/6	1.53/2.11/ 2.65
9	2.4/3.5/5.2	0.14×0.17	6	4.2/2.9/4.5	1.5/2.54/ 1. 16
This work	0.92/2.08/ 3.59	0.14×0.17	6	40.21/10.1/ 16.15	0.41/1.39/ 1.97

V. CONCLUSION

A small SLR-based triple-band band pass filter is required for this purpose. To create the extra pass band, four loaded open stubs were connected together. Small, the fake filter has dimensions of 30 x 37 mm2. The results of the simulation and computation are quite similar. According to its frequency response, the recommended filter has low insertion loss, high return loss, and a sharp skirt, making it perfect for 0.9 GHz GSM900, 2.1 GHz 3G, and 3.5 GHz WiMAX3.5 applications.

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