# High Selective Dual -band Bandpass Filter Design with Novel Feed Scheme

Chun-Yueh Huang, Yong-Xiang Xu, Ru-Yuan Yang

***Abstract*—In this paper, we propose a novel approach for designing planar dual-band bandpass filter on a novel feed scheme. While we design this filter, the novel feed scheme is used to generate two passbands at 1.8 GHz and 2.4 GHz for global system for mobile communications (GSM) and wireless local area network (WLAN). Novel feeding structures are introduced to simultaneously feed the resonators and conveniently control the zero-degree feed structure. A novel scheme is introduced to feed one set of resonators to not only generate the lower passband but also feed another set of resonators. For enhancing the selectivity, this scheme use zero-degree feed structure to generate three transmission zeros at 1.5GHz, 2.1 GHz and 2.47 GHz.**

***Index Terms*—Bandpass filter (BPF), dual-band, feed scheme, source-load coupling, zero-degree feed structure.**

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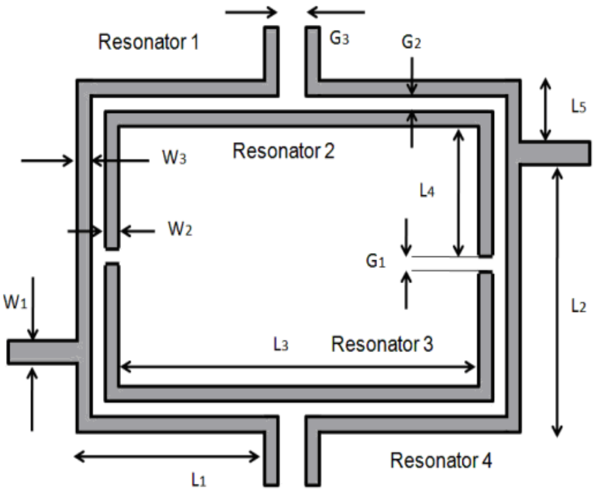


Fig.1 Structure of the proposed dual-band planar filter.

## I. Introduction

For ever-increasing demand of the dual-band wireless communication systems, compact-size and high performance dual-band bandpass filter (BPF) is widely adopted. For example, global systems for mobile communications (GSM) and their generation wideband code division multiple access (WCDMA) mobile communications operate at both 0.9 GHz and 1.8 GHz [1]. The dual-passband operation for RF circuits has become a demand after the recent development in the wireless communication [2]–[5].

In this letter, a novel feed scheme is introduced for designing dual-band bandpass filter. The main resonators control the low-band resonant frequency and the sub resonators control the high-band resonant frequency. The measurement results show a good agreement with those predicted by the IE3D full-wave simulator.

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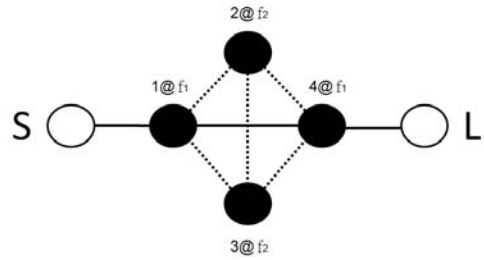
## II. Topology and Mechanism

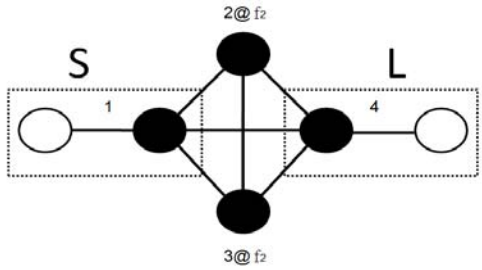
Fig. 1 shows the configuration of the proposed microstrip planar dual band bandpass filter by using novel feed scheme structure. This is a two-order filter with a symmetrical structure and consists of two sets of half-wavelength resonators. The resonator 1 and resonator 4 are used to generate the lower passband with center frequency $f_1$ = 1.8 GHz, resonator 2 and resonator 3 are utilized for yielding the upper passband at $f_2$ = 2.4 GHz. Open-circuited couple lines are employed to realize electrical coupling embedded not only between the one set resonators 1 and 4 but also resonator 2 and 3. Mixed coupling mechanisms exist in the filter between whole resonators in this case. Two 50 Ω lines are connected to resonator 1 and resonator 4, acting as input and output ports. A zero-degree feed structure [6] is adopted in the design of the resonator 1 and resonator 4. The zero-degree feed structure is used to create transmission zeros near the passband edges. Thus the feed and coupling schemes vary with frequency and thus should be addressed at respective resonant frequencies. They are designed and fabricated on an RT/duroid 5880 substrate with a thickness h=25 mil and a relative dielectric constant $\varepsilon_r$ = 2.2.

Fig. 2(a) illustrates the feed and coupling schemes at lower resonant frequency, where the black and white points represent resonators and source/load, respectively. At $f_1$, resonator 1 and resonator 4 resonate and the coupling between them is strong. In contrast, the coupling between resonator 2 and resonator 3 is relatively weak because of their non-resonance at $f_1$. By the way, resonator 2 and resonator 3 function as loading energy from resonator 1 and resonator 4, which shifts the resonant frequency downward and reduces circuit size. RF signals at 1.8 GHz are mainly coupled between resonator 1 and resonator 4.

Fig. 2(b) shows the feed and coupling schemes at upper resonant frequency $f_2$. Resonator 2 and resonator 3 resonate and the coupling is stronger than that between resonator1 and resonator 4 at $f_2$. Mixed coupling mechanisms exist between resonator 1 to resonators 2 and 3, resonator 4 to resonators 2 and 3. At upper resonant frequency $f_2$, resonator




(a)




(b)

Fig. 2 The feed and coupling schemes for the proposed filter. (a) At lower passband (b) At upper passband.

1 and resonator 4 do not resonate. They function as feed circuits for resonators 2 and 3, like that in [7]. Since the non-resonating points 1 and 4 to yield source-load coupling for create a pair of transmission zeros on each sides of upper passband.

## III. Fabricated Filter and Measured Results

The filter is designed and proved by a full-wave EM simulator IE3D [8]. The center frequencies of the two passbands are designed at 1.8 GHz and 2.4 GHz. The structure parameters of the filter are $L_1$= 13.8 mm, $L_2$= 16.9 mm, $L_3$= 26.6 mm, $L_4$= 10.05 mm, $L_5$= 5.7 mm, $W_1$ = 1.9 mm, $W_2$= 0.7 mm, $W_3$= 1 mm, $G_1$= 0.1 mm, $G_2$ = 0.45 mm and $G_3$= 1.3 mm. Fig. 3 shows the simulated responses. As can be observed the performance in all situations is acceptable, indicating this is a low-sensitivity design.

Fig.4 shows the photograph of the fabricated sample. Fig. 5 shows the comparison of S-parameter simulation and measurement results of the proposed filter. It is found that the measurement and simulation results are matched. The measured results of the planar dual-band bandpass filter based on a novel feed scheme have a central frequency of 1.8 GHz and 2.4 GHz for GSM and WLAN. The first passband with center frequency of 1.8 GHz has the insertion loss less than 0.5 dB and return loss greater than

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18 dB. The second passband with center frequency of 2.4 GHz has less than 1 dB insertion loss and greater than 23 dB return loss. The locations of the zeros are at 1.5GHz, 2.1 GHz and 2.47 GHz. The photograph of the dual band bandpass filter shows at Fig.5.

## IV. CONCLUSION

We have implemented a planar dual-band bandpass filter based on a novel feed scheme for GSM and WLAN. This scheme is being acted as resonators and feed circuits at different frequencies simultaneously. Meanwhile, source-load coupling and zero-degree feed are helpful to create transmission zeros. Three transmission zeros are realized, insertion loss greater than 20 dB in the stopband lower than 1.6 GHz and from 2.47 to 4.5 GHz. The high performance, planar structure and compact size make it attractive for wireless communications.

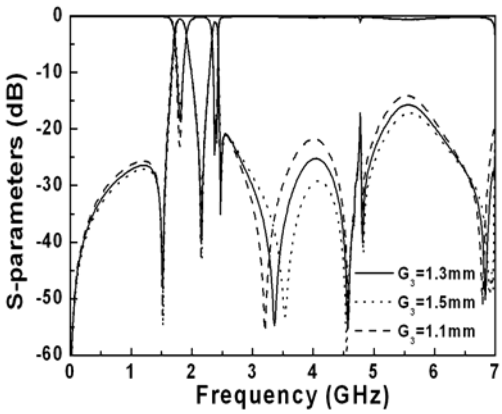


Fig. 3 The simulated responses for different gap $G_3$.

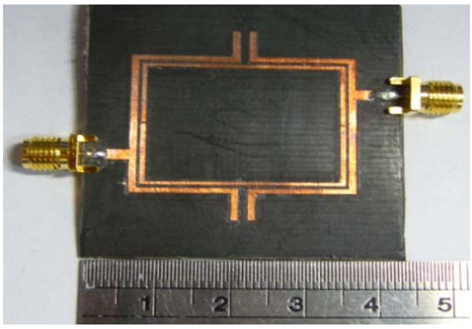

Fig. 4 Photograph of the dual band bandpass filter a 1.8 GHz and 2.4 GHz.

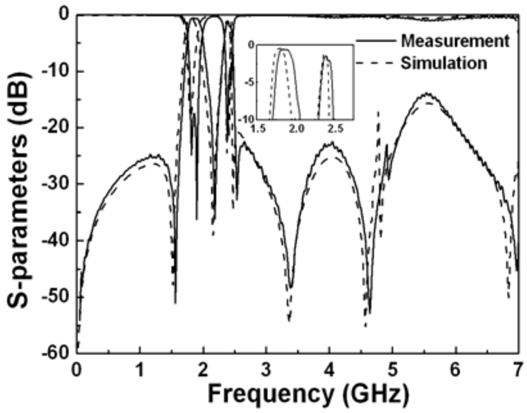


Fig. 5 Simulated and measured results.

## REFERENCES


[1] C. Y. Chen, C. Y. Hsu, and H. R. Chuang, "Design of Miniature Planar Dual-Band Filter Using Dual-Feeding Structures and Embedded Resonators," *IEEE Microw. Wireless Compon. Lett.*, vol. 16, pp. 669–671, Dec. 2006.

[2] H. Miyake, S. Kitazawa, T. Ishizaki, T. Yamada, and Y. Nagatomi, "A miniaturized monolithic dual band filter using ceramic lamination technique for dual mode portable telephones," in *IEEE MTT-S Int. Dig.*,1997, vol. 2, pp. 789–792.

[3] C. Quendo, E. Rim, and C. Person, "An original topology of dual-band filter with transmission zeros," in *IEEE MTT-S Int. Dig.*, 2003, vol. 2, pp. 1093–1096.

[4] H. M. Lee, C. R. Chen, C. C. Tsai, and C. M. Tsai, "Dual-band coupling and feed structure for microstrip filter design," in *IEEE MTT-S Int. Dig.*,2004, vol. 3, pp. 1971–1974.

[5] L. C. Tsai and C. W. Hsue, "Dual-band bandpass filters using equal length coupled-serial-shunted lines and Z-transform technique," *IEEE Trans. Microw. Theory Tech*, vol. 52, no. 4, pp. 1111–1117, Apr. 2004.

[6] C. M. Tsai, S. Y. Lee, and C. C. Tsai, "Performance of a planar filter using a zero-degree feed structure," *IEEE Trans. Microw. Theory Tech.*, vol. 50, no. 10, pp. 2362–2367, Oct. 2002.

[7] C. S. Cho, J. W. Lee, and J. Kim, "Dual- and triple-mode branch-line ring resonators and harmonic suppressed half-ring resonators," *IEEE Trans. Microw. Theory Tech.*, vol. 54, no. 11, pp. 3968–3974, Nov. 2006.

[8] IE3D Version 9.0 Zeland Software Inc., Fremont, CA, 2000.


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