# Characteristics of Dual-band Microstrip Filter with Modified E-shape Resonator

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## 1. Introduction

The increasing demand of wireless communication application necessitates RF transceivers operating in multiple separated frequency bands such that user can access various services with a single multimode handset or terminal. For example, high-speed wireless LANs, offering user up to 54 Mbit/s wireless access service, operating at 2.4 and 5.2 GHz bands. [1-6]. The demand of multiple separate frequency bands for filter become more and more importance in the wireless communication system. Low cost and easy integration are the key issues for microwave circuit technologies. In the wireless communication system, filter with small size, low cost, easy fabrication, high performance, and multi-frequencies have attracted much interest. To meet these demands, attention has been focused on the dual-band microstrip filter because of the advantages of low cost, small size, and light weight. In this paper, the dual-band microstrip filter with the modified E-shape resonator at the demand frequency of WLAN communication technology is presented. The operating frequencies are designed at 2.4 and 5.2 GHz. The key parameters to operate for single frequency band requirement are obtained in section II. In section III, the microstrip E-shape resonator is modified to yield a dual band performance by adding rectangular microstrip on the modified E-shape microstrip structure. The principle is verified by simulation and measurement. In section IV, conclusion of the proposed filter is drawn.

## 2. Configuration of Microstrip E-shape Resonator

Let us consider the conventional E-shape resonator as shown in Fig 1. The configuration of the microstrip E-shape resonator has overall dimension of 25 mm×16 mm. The structure is performed on FR-4 substrate with dielectric constant of 4.3, loss tangent of 0.025 and thickness of 0.8 mm. The strip width of the E-shape resonator is defined by $W_1$, the length of the E-shape resonator is defined by $L_1$, the width and the length of the arm of E-shape resonator are defined by $W_2$ and $L_2$ respectively, the width of coupling strip is $W_3$ and the length of the body of E-shape resonator is denoted by $L_3$.

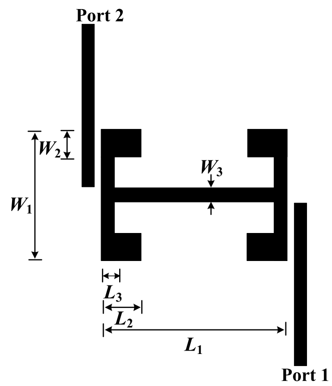
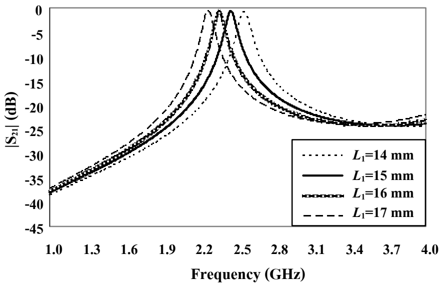
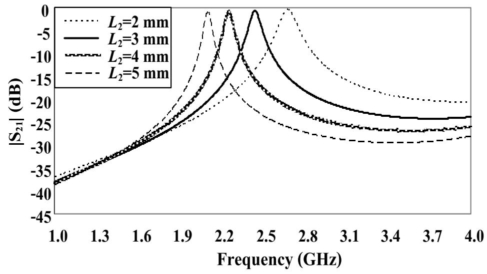



Figure 1: Single band microstrip filter with E-shape resonator.

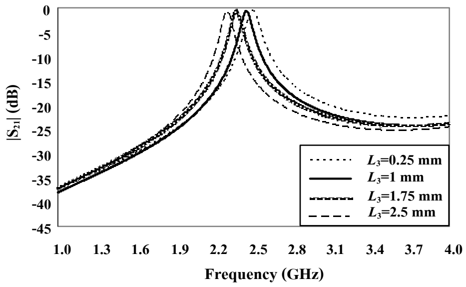
Fig. 2(a) to 2(f) shows the frequency response of $|S_{21}|$ for various $L_1$, $L_2$, $L_3$, $W_1$, $W_2$, and $W_3$ of the microstrip E-shape resonator. It is found that the suitable parameter affected to the resonant frequency. The length $L_1$ with the dimension of 15 mm and, the width $W_1$ with the dimension of 3.59 mm are selected for 2.4 GHz. When varying the parameter $W_2$ and $L_2$, :It is found from the result in Fig. 2(b) and (e) that the suitable parameter are 2 mm and 3 mm, respectively. The frequency response of various parameters of $L_3$ and $W_3$ are investigated. It is found from the result in Fig 2(c) and (f) that the suitable parameters are identical and equal to 1 mm. The advantages of E-shape resonator are small size and single narrow bandwidth. The suitable parameters of the single band are shown in the table 1.



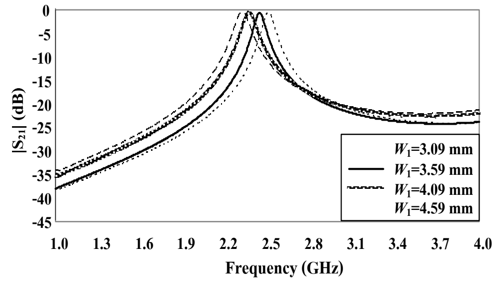

(a) $|S_{21}|$ for different $L_1$



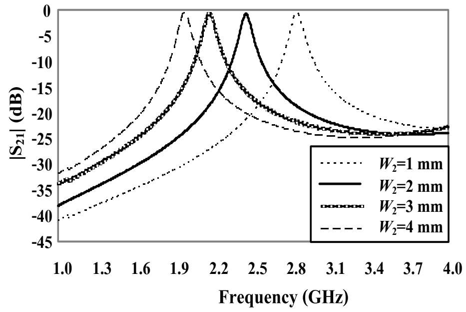

(b) $|S_{21}|$ for different $L_2$



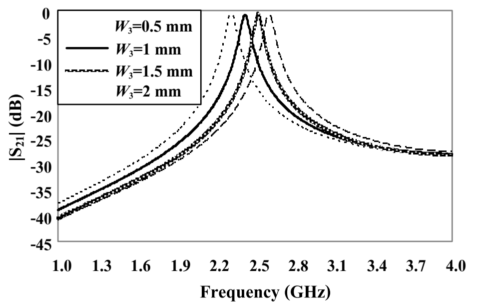

(c) $|S_{21}|$ for different $L_3$




(d) $|S_{21}|$ for different $W_1$




(e) $|S_{21}|$ for different $W_2$




(f) $|S_{21}|$ for different $W_3$

Figure 2: Frequency response of $|S_{21}|$ for different parameter $L_1$, $L_2$, $L_3$, $W_1$, $W_2$, and $W_3$

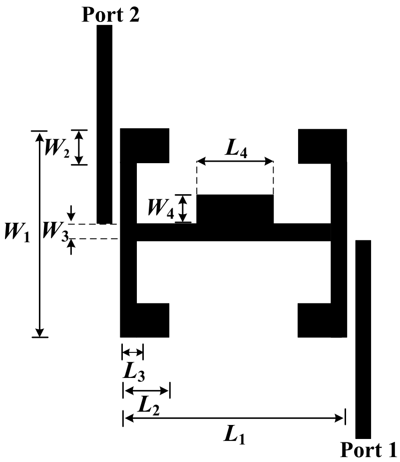
Table 1: Parameters of the Single band Microstrip E-shape Resonator

| Parameter | Size (mm) |
|---|---|
| $L_1$ | 15 |
| $L_2$ | 3 |
| $L_3$ | 1 |
| $W_1$ | 3.59 |
| $W_2$ | 2 |
| $W_3$ | 1 |

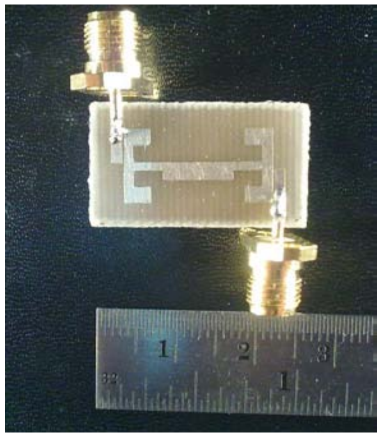
The microstrip bandpass filter will be modified to operate in dual-band application by adding rectangular microstrip within microstrip E-shape resonator. Fig. 3 (a) illustrates the proposed structure. The photograph of the prototype filter is revealed in Fig. 3 (b).

## 3.Dual-band Microstrip Filter Design

In this section, the design of filter and the simulated results are shown.



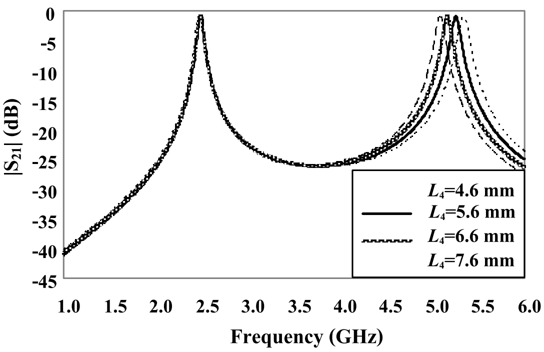

(a) Dual-band microstrip filter with modified E-shape resonator



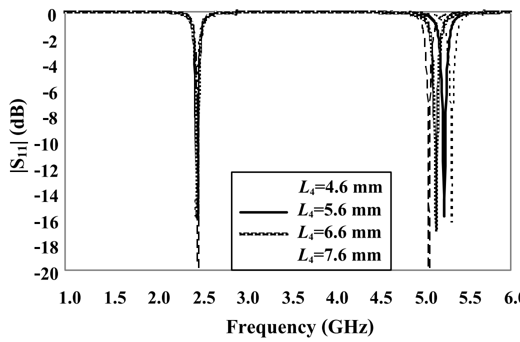
(b) Photograph of the dual-band microstrip filter with E-shape resonator.

Figure 3: Modified E-shape resonator with additional rectangular microstrip.

Fig. 4 (a) and (b) illustrate the $|S_{21}|$ and $|S_{11}|$ as a function of $L_4$ (rectangular microstrip length), respectively. The suitable length of $L_4$ is equal to 5.6 mm. Fig. 5 (a) and (b) illustrate the $|S_{21}|$ and $|S_{11}|$ as a function of $W_4$ (rectangular microstrip width), respectively. The suitable width of $W_4$ is equal to 1.5 mm. The $|S_{11}|$ of $L_4$ and $W_4$ along the pass band is lower than -10 dB.

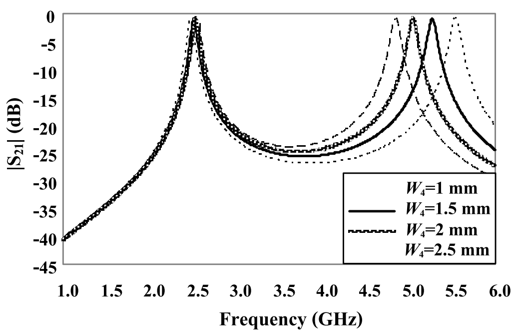



(a) $|S_{21}|$ for different $L_4$

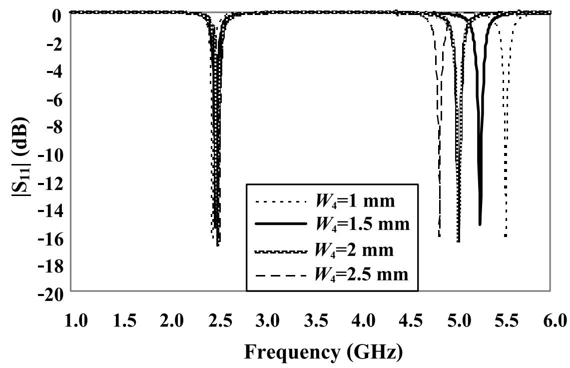



(b) $|S_{11}|$ for different $L_4$

Figure 4: Frequency response of $|S_{21}|$ and $|S_{11}|$for different parameter $L_4$



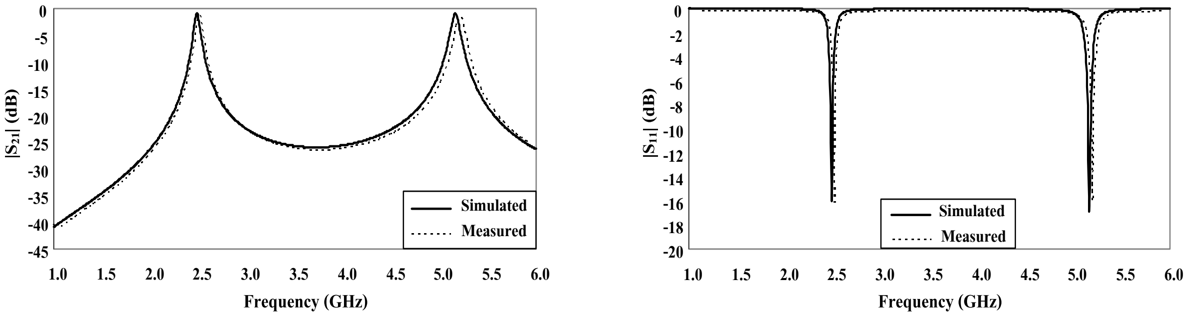

(a) $|S_{21}|$ for different $W_4$




(b) $|S_{11}|$ for different $W_4$

Figure 5: Frequency response of $|S_{21}|$ and $|S_{11}|$for different parameter $W_4$

Fig. 6 shows the simulated and measured results of $|S_{21}|$ and $|S_{11}|$ as a function of frequency. It is found from the result that of 2.4 GHz the measured $|S_{21}|$ is agree very well. The $|S_{11}|$ is lower than -10 dB along the pass band. At 5.2 GHz the measured $|S_{21}|$ and $|S_{11}|$ at 100 MHz are shift from desired frequency due to the loss.




(a) $|S_{21}|$ versus frequency (b) $|S_{11}|$ versus frequency

Figure 6: Simulated and measured dual band microstrip filter with modified E-shape resonator at 2.4 and 5.2 GHz

## 4. Conclusion

The proposed dual-band microstrip bandpass filter with the size of 25 mm × 16 mm was designed for high rate wireless communication (WLAN). The dual-band microstrip bandpass filter is achieved for dual frequency band at 2.4 and 5.2 GHz. The microstrip E-shape resonator and its optimized dimension were simulated by CST (Microwave Studio) program. It is found that the small size meets the system requirement. The design is initiated by using microstrip E-shape resonator. The result of single band frequency at 2.4 GHz is obtained. These parameters achieve the result of single frequency band of desired frequency. The microstrip filter with E-shape structure was modified to operate in a dual band frequency by adding rectangular microstrip within the microstrip E-shape resonator. It is found that the dual band frequency at 2.4 and 5.2 GHz propose. The results indicate that by adjusting the $L_4$ of the microstrip corresponding to $W_4$ can yield the suitable frequency. It is apparent that dual resonator at the desired the frequency of can be straight forwardly designed. The simple structure and small size this microstrip resonator makes it very promising candidate for WLAN technology.

## References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