

A New Compact Microstrip Ultra-Wideband (UWB) Bandstop Filter with Good Performance

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Abstract—A new compact ultra-wideband (UWB) bandstop filter with good performance is proposed. The proposed UWB bandstop filter is composed of two pairs of quarter-wavelength resonators, a high impedance main transmission line, a half-wavelength resonator, and an H-shaped multiple-mode ring resonator. The proposed H-shaped multiple-mode ring resonator is introduced to achieve three transmission poles appearing in the lower and upper passbands thus to improve the characteristics of selectivity. The proposed quarter-wavelength resonators and half-wavelength resonator are used to obtain four transmission poles showing up in stopband thus to improve the in-band suppression characteristics. To validate the design concept, a new compact UWB bandstop filter with high selectivity and good suppression is designed and fabricated. UWB stopband, low insertion losses, and good selectivity are achieved as demonstrated in both simulation and experiment.

1. INTRODUCTION

Ultra-wideband (UWB) radio technology has attracted much attention since the U.S. Federal Communications Commission (FCC) allocated a frequency range with a bandwidth of 7.5 GHz (3.1 ~ 10.6 GHz) for unlicensed radio applications [1]. Many applications have been developed based on UWB technology such as short-range broadband communication, radar sensing, and body-area networking. Bandstop filter is one of the key building blocks in modern communication system. It plays a major role of filtering out the unwanted signals and passing the desired signal. Active devices, such as oscillator and mixer, are often followed by bandstop filters to remove the higher order harmonics and other unwanted spurious signals, respectively. Moreover, numerous microwave components including diplexers and switches are also composed of bandstop filters.

Microstrip-line bandstop filters have the advantages of low cost, low weight, and ease of implementation. A conventional microstrip bandstop filter [2] is composed of shunt open-circuited resonators that are quarter-wavelength long and straight with connecting lines that are also quarter-wavelength long. However, the bandstop filters normally have narrow stopband. As wide stopband response is required in bandstop filters, the techniques of photonic band gap periodic structures and defected ground plane structures are alternative solutions [3–6]. However, they are all based on multi-layer structures that would increase fabrication cost and hardly compatible with the existing microwave-integrated circuit.

In this communication, a new compact ultra-wideband (UWB) bandstop filter with high selectivity and good suppression is proposed. The present UWB bandstop filter is composed of two pairs of quarter-wavelength resonators, a high impedance main transmission line, a half-wavelength resonator, and an H-shaped multiple-mode ring resonator. The proposed H-shaped multiple-mode ring resonator is

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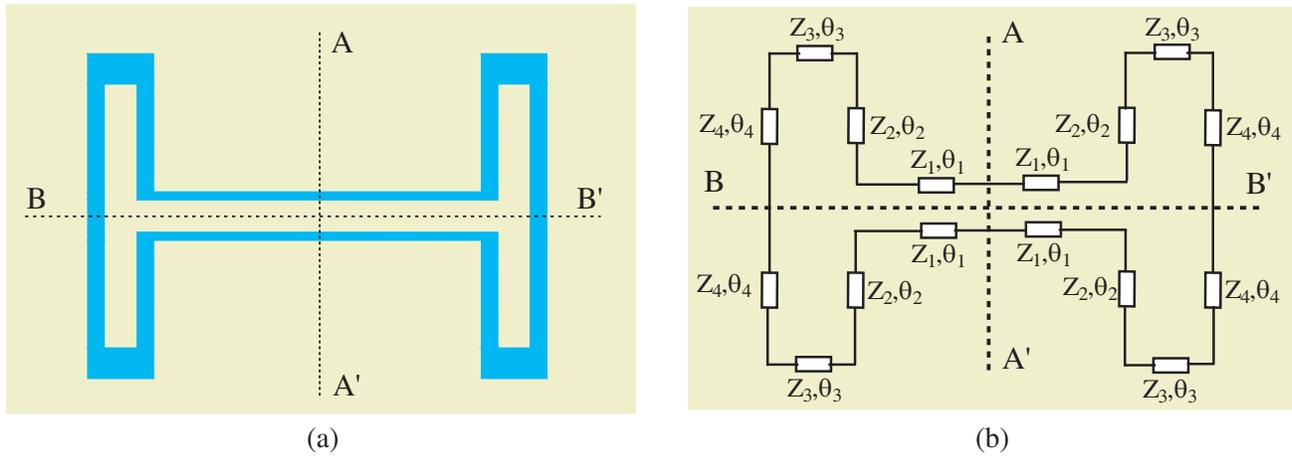


Figure 2. Schematic layout and equivalent circuit network of the presented H-shaped multiple-mode ring resonator. (a) Schematic layout. (b) Equivalent transmission line network.

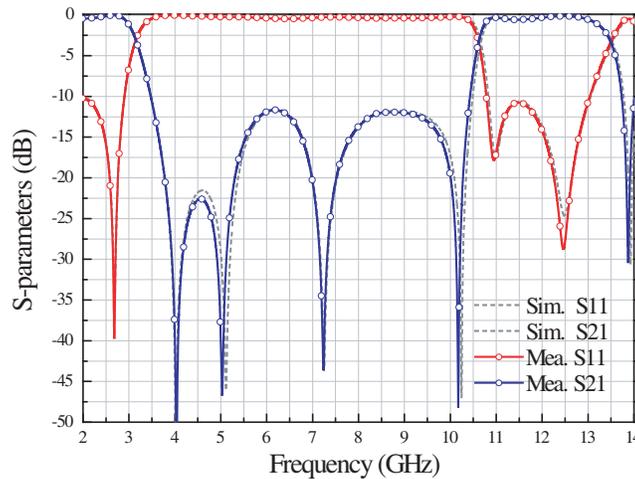


Figure 3. Simulated and measured S -parameters of the designed UWB bandstop filter.

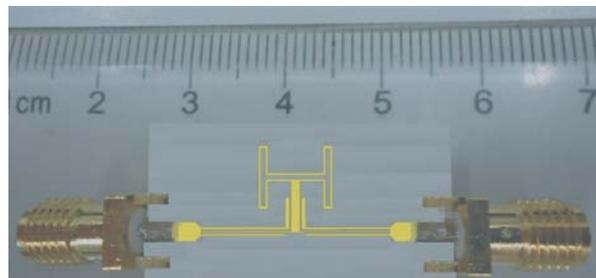


Figure 4. Photograph of the fabricated UWB bandstop filter.

described in Fig. 3 with good agreement. Referring to Fig. 3, the fabricated UWB bandstop filter with good performance has a stopband from 3.1 GHz to 10.6 GHz, and the 3 dB fractional bandwidth (FBW) is 110%. In addition, the stopband return loss is smaller than 0.4 dB in the range of 3.1 GHz to 10.6 GHz. As shown in Fig. 3, the attenuation levels in the band from 3.46 GHz to 10.45 GHz are larger than 10 dB.

The measured out-of-band return loss in the range of 2.0 GHz to 2.9 GHz is larger than 10 dB while the measured out-of-band return loss in the range of 10.8 GHz to 13.0 GHz is larger than 10 dB. Moreover, the passband insertion loss is smaller than 0.5 dB in the range of 2.0 GHz to 2.9 GHz and smaller than 0.7 dB in the range of 10.8 GHz to 13.0 GHz. Four transmission zeros are produced at 4.0 GHz, 5.1 GHz, 7.2 GHz, and 10.2 GHz in the entire stopband, which contribute to improving the in-band suppression characteristics. Additional three transmission poles are generated at 2.7 GHz, 10.9 GHz, and 12.4 GHz in lower- and upper-passbands for achieving good selectivity.

The deviations of the measurements from the simulations are expected mainly due to the reflections from the connectors and the finite substrate. Fig. 4 shows a photograph of the fabricated UWB bandstop filter. The overall size is only $23 \times 13 \text{ mm}^2$.

3. CONCLUSION

A novel compact ultra-wideband (UWB) bandstop filter with high selectivity and suppression characteristic is proposed. The present UWB bandstop filter is composed of two pairs of quarter-wavelength resonators, a high impedance main transmission line, a half-wavelength resonator, and an H-shaped multiple-mode ring resonator. The proposed H-shaped multiple-mode ring resonator is introduced to achieve three transmission poles zeros appearing in the lower and upper passbands thus to improve the characteristics of selectivity. The proposed quarter-wavelength resonators and half-wavelength resonator are used to obtain four transmission poles showing up in stopband thus to improve the in-band suppression characteristics. For demonstration, a new microstrip UWB bandstop filter is designed, simulated, and measured. Good agreement between simulation and measurement results demonstrates the validity of the method. The proposed filter is very useful for modern UWB wireless communication systems due to its simple topology, compact size, and excellent performance.

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