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Analysis and Design of Multi-Band Bandstop Filter

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Abstract

This paper presents a multi-band bandstop filter (MBBSF) that features four controllable stopbands at 1.1 GHz, 3.2 GHz, 5.4 GHz and 7.5 GHz frequencies. A drastic reduction in size of the filter was achieved by taking advantage of a simplified architecture based on E-shaped resonator. The return losses of the simulated filter are measured to be -43.44, -45.34, -39.66 and -36.81 dB while the insertion losses are -0.01, -0.03, -0.24 and -0.15 dB at the respective stop bands. Filter is designed on FR-4 substrate with dielectric constant 4.3 and group delay (ns) of filter is less than 0.5 in pass bands. Due to its satisfactory stopband performance, the filter can be useful for modern communication technology.

Keywords: - Bandstop filter (BSF), multi-band (MB) filter, E-shaped resonators.

Introduction

Planar filters are well popular for the advantages of compact size, low cost and low loss, since they can be widely used in microwave circuits and communication systems. In modern communication systems, bandstop filters are largely used to avoid the unwanted signals and interferences. To date, various bandstop filter design methods have been introduced such as using dual-mode loop resonators [1], open-circuited stubs [2], patch resonators [3], waveguides [4], etc. Moreover, multi-mode bandpass/bandstop filters also have an important role in communication system design because of their great advantages for miniaturisation [5, 6].

The multi-band bandstop filter (MBBSF) has evolved rapidly and has lead to dramatic demand for lower cost product with a compact size and strong communication capability. Compared to single-band and dual-band filters, these filters are more popular owing to their advantageous of miniaturize size. Now a days increasing number of researchers have paid their attention to explore multi-band filters as a key component for future evolving WiMAX applications.

Recently, microwave passive components and devices with multi-band operation become more and more important in modem communication systems and have been focused much attention for the miniaturization and multifunction requirement of the portable equipments [7-9]. Multiple band microwave components with compact size and low cost are required and studied. On the other hand, multi-bandstop filters are desired for their effective suppression of spurious signals in wireless communication systems. Other advantage is its low passband insertion loss and group delay due to its resonators resonates in the stopband rather than in the passband.

The proposed bandstop filter (BSF) consisting of E-shaped resonators and Microstrip feeding line, it is obtained by modifying a compact dual-band bandpass filter using quadruple-mode square ring loaded resonator (SRLR) which is originally proposed in 2013 for bandpass application [10].

Design of Multi-Band Bandstop Filter

The proposed structure consist E-shaped resonators and microstrip feeding line which is fabricated on FR4 substrate having dielectric constant of 4.3 and thickness of substrate is 1 mm. The characteristics impedance of the feed line is 100 ohm. Figure1 shows a layout of the designed filter. This layout consist a centrally loaded resonator. A loading element is attached at the center of the transmission line. The transmission line can be either uniform or nonuniform. Moreover, it can be a microstrip line or other unbalanced transmission line. Under all these conditions, the resonator has similar characteristics.

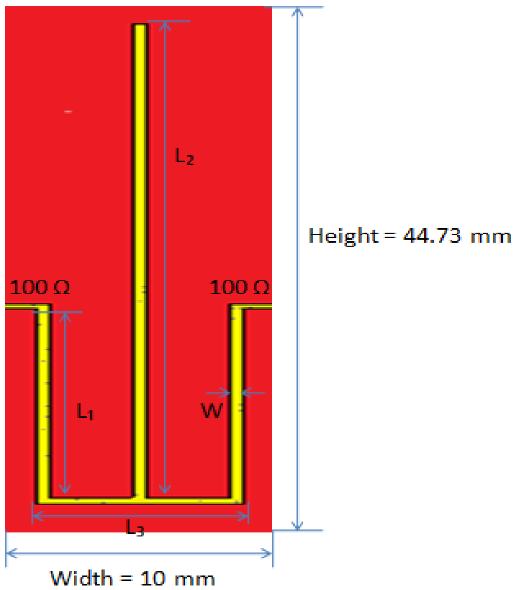


Figure 1 Layout of the designed multi-band BSF

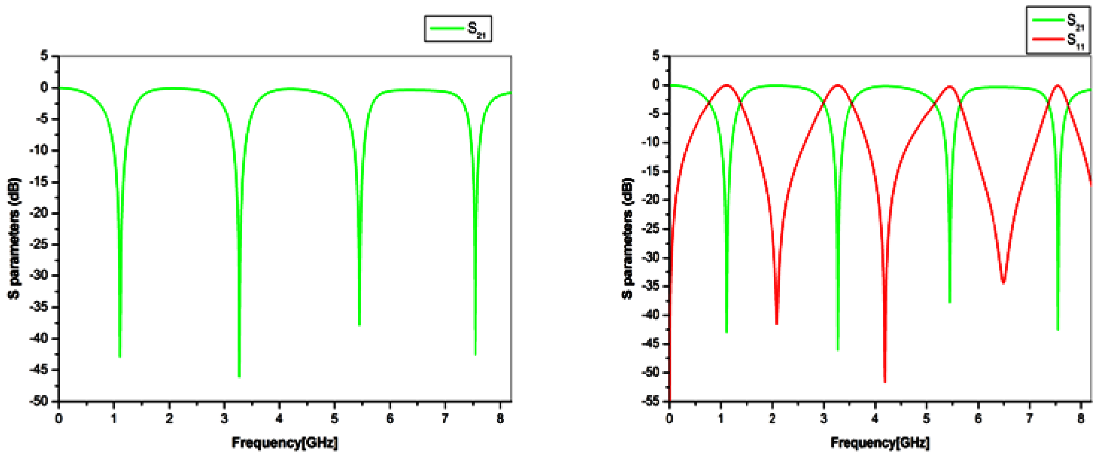
Table 1 Dimensions of the Multi-Band Bandstop Filter

Simulated Results

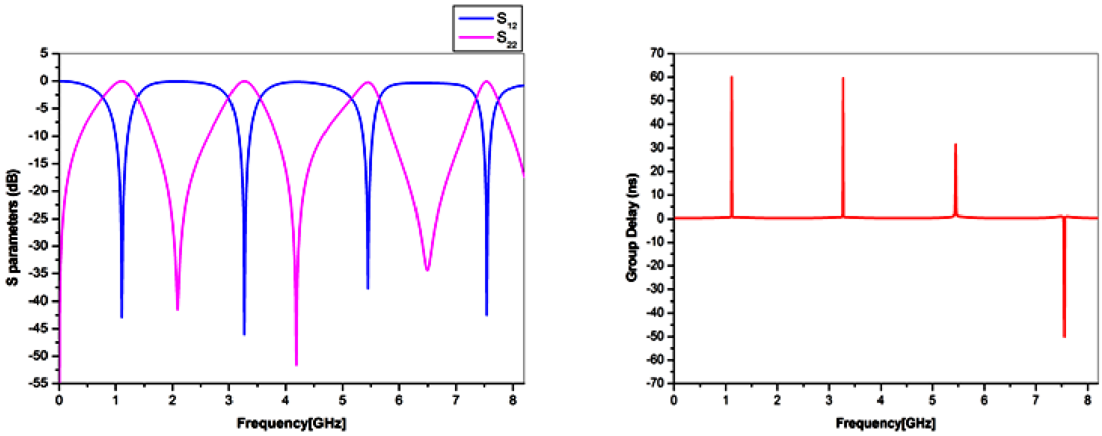
Based on the investigation above, a multi-band bandstop filter is simulated, as shown in Figure 1. S-parameters and group delay response measurements are performed using CST software over the frequency range from 0 to 8 GHz. Figure 2 demonstrates the simulated results of the proposed filter. The proposed filter exhibits a good bandstop performance at 1.1 GHz, 3.2 GHz, 5.4 GHz and 7.5 GHz. The circuit dimension is 10 mm by 44.73 mm and group delay is less than 0.5 in pass band.

Table 2 Simulated Results of the Proposed Multi-Band Bandstop Filter

Parameter	Simulation
Center frequency (GHz)	1.1, 3.2, 5.4 and 7.5
Insertion loss , (dB)	-0.01, -0.03, -0.24 and -0.15
Return loss , (dB)	-43.44, -45.34, -39.66 and -36.81
Group delay	Less than 0.5 in pass band



(a) (b)



(c) (d)

Figure 2 Simulated results of the multi-band bandstop filter

Conclusion

This paper presents the synthesis of the multi-band bandstop filter (MBBSF) with E-shaped resonators. The circuit has four stopbands at 1.1 GHz, 3.2 GHz, 5.4 GHz and 7.5 GHz with controllable center frequencies and bandwidths. Rejection level at desired frequencies is -43.44, -45.34, -39.66 and -36.81 while pass band insertion loss is almost 0 dB and group delay (ns) is less than 0.5 in pass bands. Multi-band performance is attained simultaneously by using the E-shaped resonators. Due to its satisfactory stopband performance, the filter can be useful for modern communication technology.

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