A compact waveguide bandpass filter design using folded waveguide resonant cavities

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1. Introduction

Thanks to the advantages of low loss, high-power handling, stable structure and performance, waveguide bandpass filters have been widely used in the transceiver circuits of various communication systems such as satellites, bases stations, and radars. However, waveguide filters typically have a bulky design, make the installation a challenge task. In this work, we first proposed a compact resonant cavity that shaped like a folded waveguide. Then a compact waveguide bandpass filter is developed using the folded waveguide cavities. The presented resonant cavity and filter can be developed using the conventional waveguide filter design theory. As a result, the proposed waveguide filter is not only compact in size, it can also be easily carried out by the existing design method without complex treatments.

2. Design and Results

To demonstrate the proposed waveguide filter design, a 4th-order bandpass filter having the center frequency f_0 = 5.2 GHz, fractional bandwidth FBW = 2%, and in-band return loss RL ≥ 20 dB, is considered. The WR-159 rectangular waveguide with cross sectional dimensions of 40.4 mm in width (a) and 20.2 mm in height (b) is adopted in the tested example. In the conventional design, a 5.2 GHz resonant cavity is first designed by a segment of closed WR-159 waveguide. The length (l) of the cavity can be readily calculated as 41.2 mm. By cascading 4 cavities with suitable coupling design, the considered bandpass filter is then obtained. The size of the resulting filter is about 40.4 × 20.2 × 170 mm^3, which is obviously bulky. The waveguide filter can be miniaturized by reducing the size of the resonant cavity. From the basic electromagnetic theory, it is shown that the resonant mode considered in the filter design is the fundamental mode (TE_{101} mode), and its resonant frequency is independent of the cavity height, b. One can thus reduce the height of the cavity without changing the resonant frequency. Further, by folding the cavity from the middle of its length (see Fig. 1), a more compact resonant cavity can be then achieved. Appling the filter design theory to cascade the folded waveguide resonant cavities, a compact waveguide bandpass filter is finally obtained. Fig. 2 shows the measured frequency responses of the designed compact waveguide filter. It is seen that the return loss (S_{11}) and insert loss (S_{21}) are quite match the specifications. Although not shown here, it has also been found that the performances of the proposed waveguide filter are very closed to those of the conventional ones. Moreover, the dimension of the implemented filter is about 41.1 × 20 × 27 mm^3. Compared to the conventional design, the proposed filter can achieve a remarkable 84% reduction in size. The presented technique is therefore a practical approach for the design of miniaturized waveguide bandpass filters.

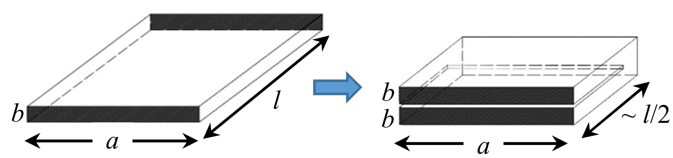

Fig. 1 Modify a conventional waveguide cavity to a folded waveguide cavity.

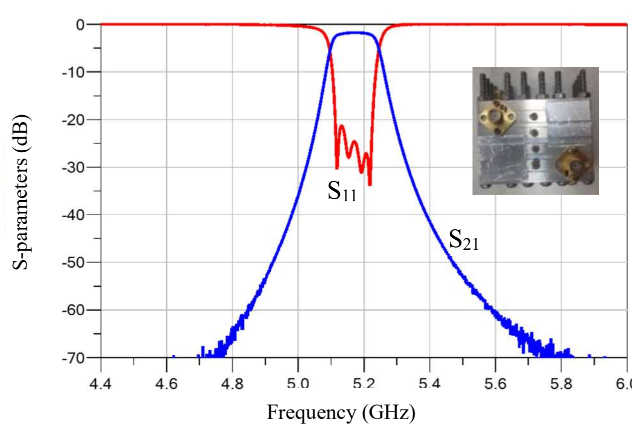

Fig. 2 The measured frequency responses of the proposed compact waveguide bandpass filter.

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