A Filtering Slot Antenna by the Air-Filled Annular Waveguide Structure

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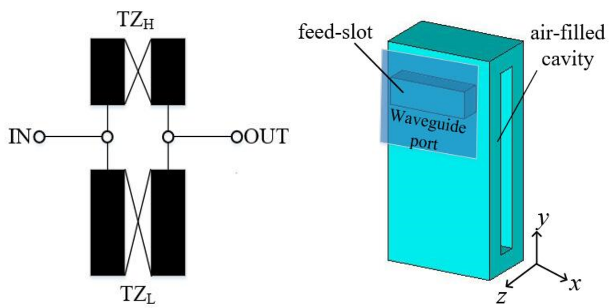
***Abstract*- A filtering slot antenna by the air-filled annular waveguide structure is presented in this paper. An annular air-filled waveguide structure is served as a 2nd-order bandpass filtering structure to feed a slot antenna, and the slot-antenna is directly embedded on the annular structure resulting in a highly integration of filtering antenna. The filtering antenna has a central frequency at 9.88 GHz and a 10dB bandwidth of 0.71% with the unidirectional radiation. There are two radiation poles in passband, while two radiation zeros on the low and high transition. To validate the proposed concept, the proposed filtering antenna is fabricated. The measured result is in considerable agreement with the simulated result.**

Index Terms*- *filtering antenna, annular air-filled waveguide, bandpass filter, second-order, two radiation poles.

I. Introduction

As the development of communication system, the integration of radio-frequency filter and antenna receives a more attention. Some excellent works are designed by integrating the microstrip filtering network and patch antenna [1] or line antenna [2], but the microstrip filtering network is difficult and is not optimal to integrate with the cavity-backed antenna. And it is clear the slot backed-cavity antennas based on the SIW structure [3, 4] have the well performance. So it is necessary to further construct slot filtering backed-cavity antenna, and using the SIW cavity filter to feed the slot antenna is a good manner in [5]. However unfortunately, the dielectric loss of SIW structure can't be negligible. Therefore, it's desired to research the slot filtering antenna by the 3-dimetional air-filled structure.



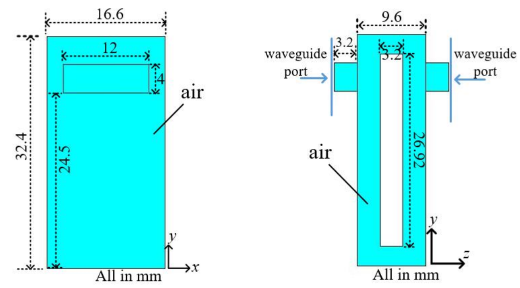


Fig. 1. The 2nd-order filter. (a) Topology. (b) Three-dimensional view. (c) Front view. (d) Left view.

In this paper, an air-filled annular cavity structure is proposed for bandpass filtering network and further radiated through a directly embedded, which provides an optional structure to construct 3-dimetional air-filled filtering antenna. And a filtering antenna is designed on the X-band with two radiated poles in the passband and two radiation zeros in the side transition.

II. Analysis and Design of Filtering Antenna

Fig. 1(a) depicts a topology of filter, which can achieve 2nd-order filtering performance, furthermore create one transmission zero in high transition (TZH) and one transmission zero in low transition (TZL) referring to [6]. Based on the topology, an annular air-filled cavity is presented, and the Fig. 1(b), (c) and (d) depicts the 3-D view, front view and left view of proposed filter respectively. The filter is packaged by the PCBs, and the cross-section view is shown in the Fig. 2(a).

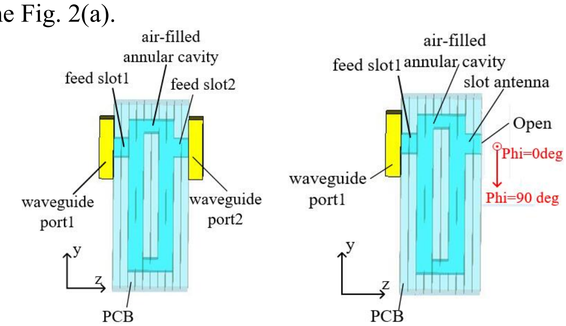


Fig. 2. The cross-section view of simulated model for proposed filter. (a) Filter. (b) Filtering-antenna

In detail, the PCB has the slot-cut, copper-deposition, and stack to generate the annular air-filled cavity. The simulated S-parameter of 2nd-order filter is presented in Fig. 3. There are two transmission zeros locating in the transition to improve the frequency selectivity. And the transmission zeros can controlled by adjusting the positon of waveguide port.

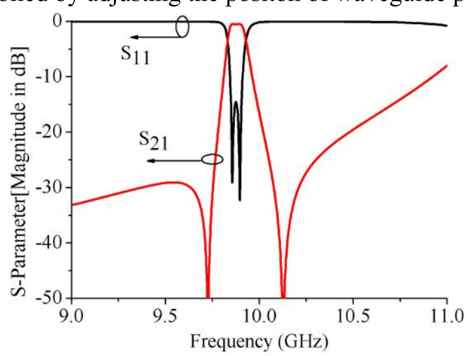


Fig. 3. The S-parameter of the proposed 2nd-order filter.

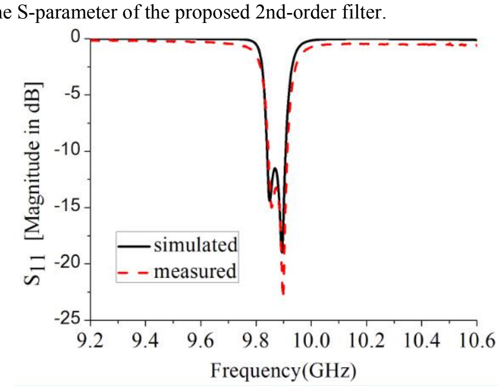


Fig. 4. Simulated and measured S-parameter of the proposed annular cavity filtering antenna.

When the waveguide port2 of proposed filter is taken off and the size of the structure is not changed, the structure will serve as a filtering slot antenna, which is shown in Fig. 2b. The annular air-filled cavity combined with waveguide port1 serve as the filtering network. The feed slot2 in the filter will serve as the slot-antenna in the filtering antenna, which is directly embedded on the filtering cavity. And the S-parameter of filtering antenna is presented in Fig. 3. Furthermore, the radiation patterns of filtering antenna is illustrated in Fig. 5, and the realized gain is presented in Fig. 6.

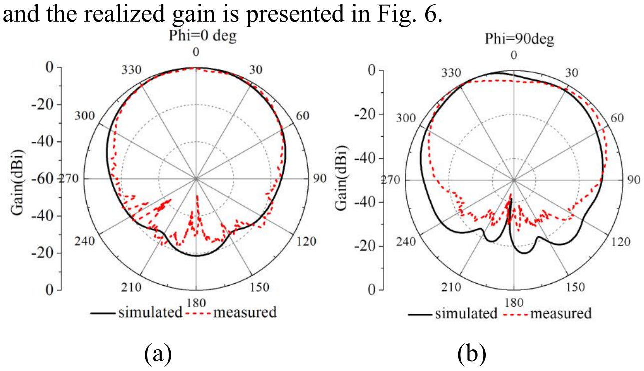


Fig. 5. Normalized radiation patterns of proposed filtering antenna.
(a) H-plane. (b) E-plane.

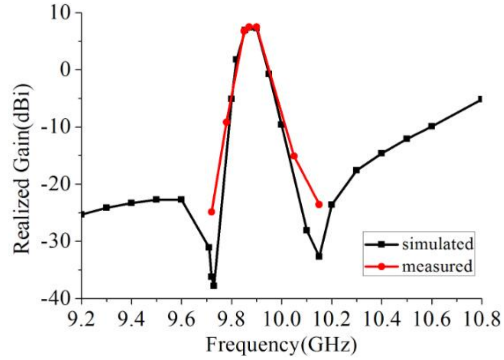


Fig. 6. Simulated and measured realized gain of the proposed filtering antenna.

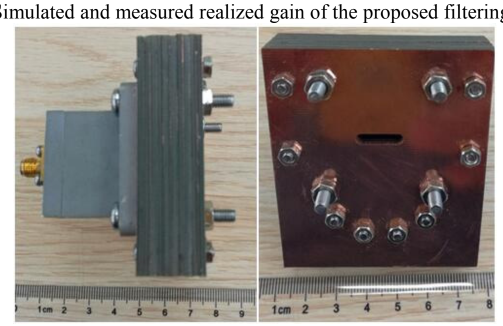


Fig. 7. The physical map of proposed filtering antenna.

III. Experimental Results and Discussion

The physical map of proposed filtering antenna is shown in Fig. 7. Some screws are utilized to fix whole PCBs structure with metal waveguide port together. The measured S-parameter, radiation patterns and realized gain are presented in Fig. 4, 5 and 6 respectively, with the simulated results. The filtering antenna functions at 9.8 GHz with a 10dB bandwidth of 0.71% and two radiation poles are in the passband. The antenna radiates along the z-axis in unidirectional pattern. The measured radiation patterns have a little deviation with the simulated especially in back lobe because the physical waveguide port is more complicated than the simulated model and has a much suppression in the back lobe of radiation patterns. And the realized gain shows the antenna has considerable frequency selectivity by emerging two radiation zeros in transition band, and the measured gain validates the roll-off degree. According to above results, the proposed filtering antenna is verified to be feasible.

IV. Conclusion

The filtering slot antenna by an air-filled annular cavity has been presented in this paper. The slot antenna was directly embedded on the annular filtering cavity to establish the filtering antenna and achieve highly integration, meanwhile the filtering antenna behaved a well frequency selectivity and unidirectional radiation. Finally, the measured result of proposed filtering antenna was in considerable agreement with the simulated result.

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