

Ka-band Wideband Filter with a Reconfigurable Mode of Bandpass-bandstop Switching

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Abstract— In this paper, a Ka-band wideband filter with a reconfigurable mode of bandpass-bandstop switching is presented. As a low-Q resonator, a rectangle ring with a straight “tail” is inserted into the central E -plane of a waveguide to realize the wideband performance. With the “ON” or “OFF” state of the PIN diode, the EM field driving by the resonator may be the same direction with or suppress the TE_{10} of the waveguide, which makes the filter be reconfigurable. At the frequency of 33 GHz–37 GHz, the insertion loss is lower than 1 dB at band-pass mode, and when it is working as a band-stop filter, the insertion loss is more than 15 dB on the whole frequency band.

1. INTRODUCTION

Recently, reconfigurable filters are taking an increasing attention for their multi-functional and low-profile features in modern wireless and mobile communication systems [1]. Studies are focus on center frequency tuning [2] and bandwidths or constant bandwidths [3] are common, and pass-stop mode reconfigurable [4], tunable rejection levels and notch of UWB tunable [5] are also popular.

Metallic waveguide filter, widely used in millimeter wave systems, has advantages of high power capability and low loss. However, its size is much larger than that of planar one. Many miniaturization technologies have been investigated to design waveguide filters [6–9].

In this paper, a modes reconfigurable wideband filter with rectangle waveguide is presented. A PIN switch and rectangle ring resonator are used to design the WIFI filter. The design and simulation are demonstrated in the following sections. In order to test the performance of the reconfigurable WIFI filter, a standard Ka-band waveguide with a width of 7.112 mm and height of 3.556 mm. substrate F4B with thickness of 0.8 mm and dielectric constant of 2.65 was used in the EM simulation with Ansys HFSS.

2. DESIGN OF PROPOSED RECONFIGURABLE FILTER

In this section, the Ka-band filter is designed to have a reconfigurable property with rectangle ring resonator and a PIN switch.

A rectangle ring resonator is low-Q [10], which will have a wideband property. In order to test the properties of a rectangle ring resonator, two simulations are utilized. They are all using a substrate with a metal layer forming the rectangle ring resonator in standard Ka-band waveguide. The

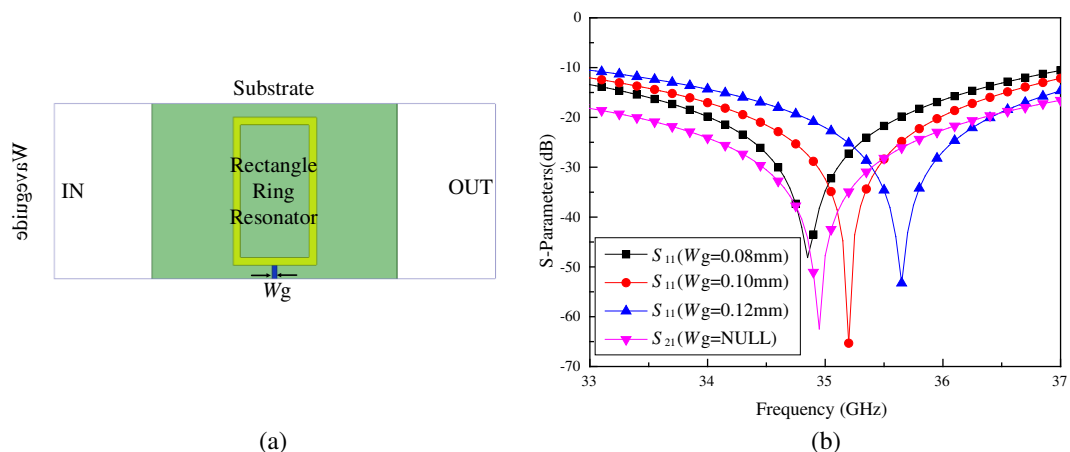


Figure 1: Performance of rectangle ring resonator. (a) Rectangle ring resonator. (b) The performance of the rectangle ring resonator.

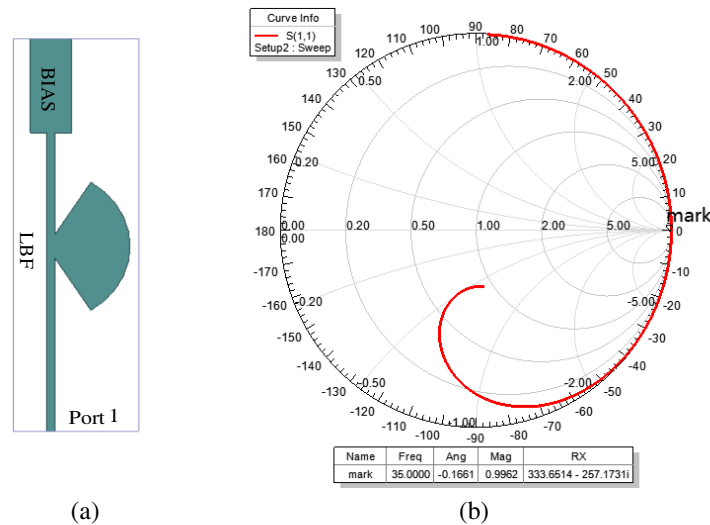


Figure 2: Bias of the PIN switch. (a) Model of the DC bias. (b) The Smith chart of the bias.

rectangle ring resonator plane is mounted along the center of wide side of the Ka-band waveguide with and without a straight “tail” ground to the waveguide, as shown in Fig. 1(a).

Figure 1(b) shows the simulation results of the tests:

When the rectangle ring resonator is alone without the “tail”, it is a band-stop filter, with a insertion loss of 65 dB at center frequency.

When the rectangle ring resonator is connect the wall of the waveguide with the “tail”, it is a band-pass filter, and has a deep reflection pole. If the width Wg can be tuned, the center frequency of the band-pass filter will be changed greatly. So, this property can be used to design a reconfigurable filter with a PIN switch changing the working state of filter.

To design the reconfigurable filter, three steps may be followed:

Firstly, make the rectangle ring resonator working at needed frequency. It can be achieved by adjusting the size of the rectangle ring resonator when it is alone without the “tail”.

Secondly, design the PIN switch position to make another mode working at center frequency. It can be achieved by adjusting the width of the “tail” Wg fixing the dimension of first step.

Lastly, design the DC bias of the PIN switch. A low-pass filter is necessary to make sure the PIN switch is working and the microwave signal would not entry the DC path. The bias circuit should be open to the microwave signal.

Figure 2 shows the model and performance of the low-pass filter: at port 1, the bias circuit is open at the center frequency which make sure the bias circuit would not influence the microwave signal or the performance of the rectangle ring resonator.

3. SIMULATION RESULTS OF THE PROPOSED FILTER

In this section, the entail model and the simulation results of a reconfigurable Ka-band filter is described.

As shown in Fig. 3(a), the PIN switch is mounted out of the waveguide, to enhance the pass-band performance and reduce the current passing the PIN switch. The blue circles are ground posts ground the PIN switch and prevent the resonance of the substrate.

Figure 3(b) shows the simulation results of the Ka-band filter:

When the PIN switch is ON: it is a pass band at the frequency range of 33 GHz to 37 GHz, with an insertion loss less than 1 dB.

When the PIN switch is OFF: it is a stop band at the frequency range of 33 GHz to 37 GHz. The insertion loss is more than 15 dB at the entail band. And at the center frequency of 35 GHz, the isolation of the input and output is about 65 dB.

The reconfigurable wideband filter is able to switching the mode of band-pass and band-stop.

4. FUTURE WORK

This technology can be combine with other reconfigurable or tunable technologies, for instance, the working frequency or bandwidth can be tuned with a varactor-based method.

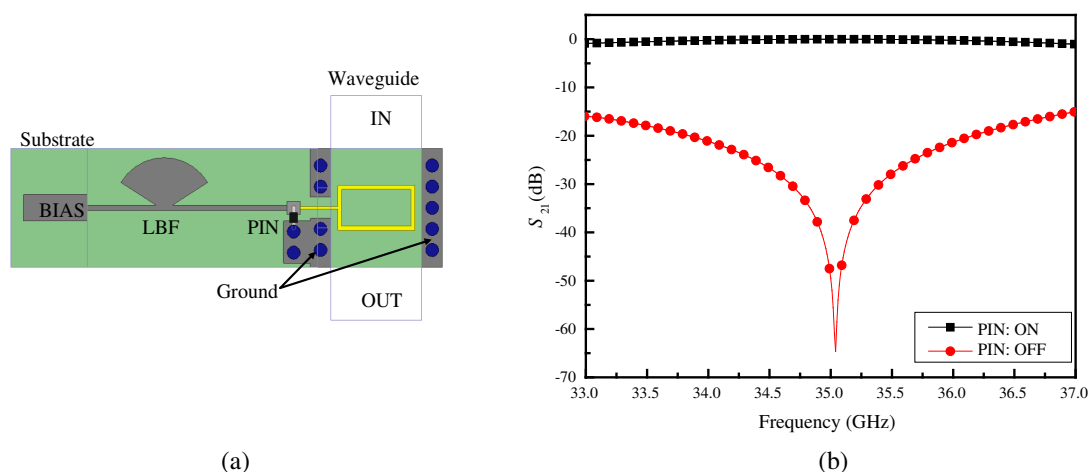


Figure 3: Simulation results of the proposed filter. (a) Entail model of the filter. (b) The simulation results of the filter with PIN switch working at different status.

5. CONCLUSION

This paper presents a Ka-band reconfigurable filter which has a function of switching band-pass and band-stop mode. A rectangle ring resonator is used to construct the resonator which will influence the EM field in the waveguide, so as to control the working state. The simulation shows At the frequency of 33 GHz–37 GHz, the insertion loss is lower than 1 dB at band-pass mode, and when it is working as a band-stop filter, the insertion loss is more than 15 dB on the whole frequency band, and at the center frequency of 35 GHz, the insertion loss is high to 65 dB. This technology can be used in microwave and millimeter wave systems.

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