Design and performance of a 340 GHz forth harmonic mixer

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Abstract—**In this letter, based on the precise modeling of the planer Schottky barrier diode (SBD) and the circuit design method which combines linear and nonlinear simulation, a 340GHz fourth harmonic mixer has been designed, fabricated and measured. At room temperature, the measured results show that the signal side band (SSB) conversion losses were from 14.2 dB to 20 dB in 333-356 GHz for the mixer with the LO frequency 85 GHz.**

I. INTRODUCTION

COMPARED with microwave and millimeter-wave, terahertz possesses the characteristics of short wavelength, wide band, large information capacity and other advantages. Nowadays, as the microwave and millimeter-wave spectrums are becoming more and more crowded, the working frequency of various electronic systems has been gradually extended to the terahertz band. Terahertz wave has broad application prospects in many fields, such as broadband communication, precision guidance, object imaging, environmental monitoring, medical diagnosis, etc. As the core device of the terahertz receiver and transmitter front-ends, mixers are widely used in communication, radar and other terahertz systems.

Due to the characteristics of extremely short working wavelength and ultra-small circuit size of terahertz mixer, it will generate complicated parasitic effect and lead a limited optimizing space for circuit matching in the terahertz design. Dealing with these problems, the precise 3D EM planar SBD model is established and the synthesis design method for terahertz mixer design is adopted. In this letter, a 340GHz forth harmonic mixer has been designed and fabricated with the method and model mentioned above. The measured results show that the fabricated mixer has good performances.

II. DESIGN

Based on the physical mechanism and structural characteristics of the planar SBD, the more accurate three dimensional electromagnetic model of the SBD is further suggested in order to solve the problem of the inaccurate intrinsic SPICE model because of the inability of model the parasitic phenomena of the SBD structure and package in the terahertz band when frequency increasing. This letter gets the complete diode model for designing 340 GHz forth harmonic mixer which primarily creates internal ports through 3D model of the Schottky diode chip, and extracts S-parameters to characterize the high frequency parasitic parameters. The suspend microstrip diode model built in HFSS is shown in Fig. 1.

Schematic of the 340GHz mixer block is shown in Fig. 2. The RF and LO signal are coupled into the suspended microwave strip channel through the waveguide-microstrip transitions. The reduced-height waveguide are used for both RF and LO rectangular waveguides to expand bandwidth. The LO low-pass filter is designed to prevent the RF signal from coupling to the LO port. Similarly the IF low-pass filter is used to prevent the LO signal from coupling to the IF port.

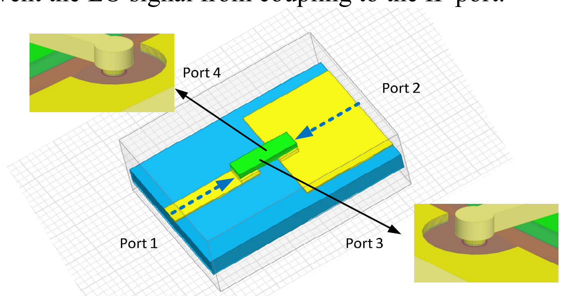

Fig. 1. The suspend microstrip diode model in HFSS

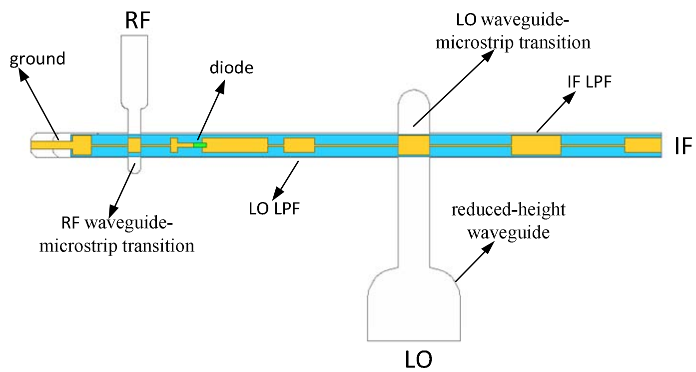

Fig. 2. The schematic of the 340GHz forth harmonic mixer.

The synthesis design method for terahertz mixer design is adopted. Each independent part of the mixer is constructed and simulated using HFSS. Then the calculated S parameters data of each part is imported to the global optimization circuit in ADS. And the simulation circuit of the 340GHz mixer in ADS is shown in Fig. 3.

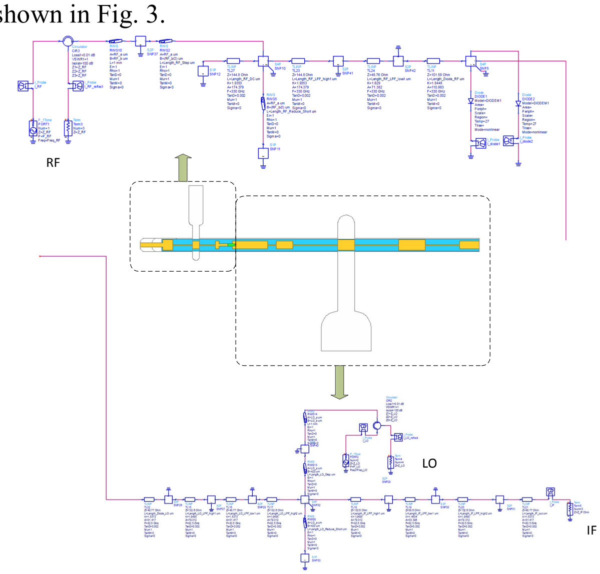

Fig. 3. The simulation circuit of the 340GHz forth harmonic mixer in ADS.

The optimum calculated SSB conversion loss is less than 15 dB as shown in Fig. 4 when RF ranges from 318-357 GHz, as LO frequency is 85 GHz.

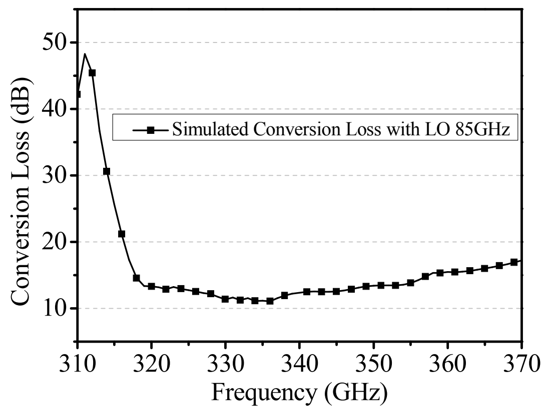

Fig. 4. The simulated SSB conversion losses of the 340GHz forth harmonic mixer.

III. Results

The photograph of the fabricated 340GHz forth harmonic mixer is shown in Fig. 5.

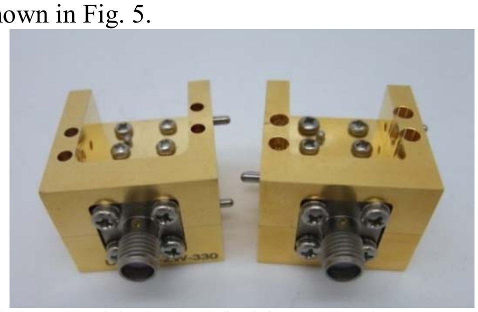

Fig. 5. The photograph of the 340GHz forth harmonic mixer.

At room temperature, the measured results show that the SSB conversion losses were from 14.2 dB to 20 dB in 333-356 GHz for the mixer with the LO frequency 85 GHz as shown in Fig. 6.

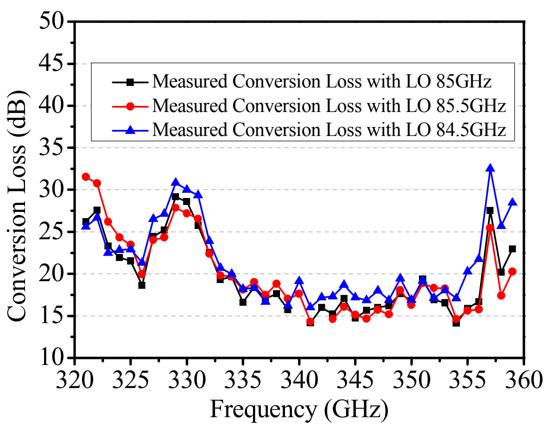

Fig. 6. The measured SSB conversion losses of the 340GHz forth harmonic mixer with various LO frequencies.

IV. Summary

In this letter, the precise 3D EM planar SBD model is established and the synthesis design method for terahertz mixer design is adopted for designing 340 GHz forth harmonic mixer. The measured results show that the fabricated mixer has good performances.

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