

Frequency Reconfigurable Rectenna for Wireless Power Transfer

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This paper demonstrates a frequency reconfigurable rectenna which can operate at both 2.45 and 5.8 GHz. It consists of a reconfigurable antenna and a dual-band rectifier. By switching the PIN diode, the reconfigurable antenna's working state can be easily changed. Compared with the common multi-band rectenna, the frequency reconfigurable rectenna has the advantage of convenient tuning, so it can achieve higher rectifying efficiency at multiple frequencies. The frequency reconfigurable rectenna can be used to supply the electrical devices in the wireless power transfer applications.

Antenna

The reconfigurable antenna which has two operating states is shown in Fig.1. A F4B substrate (relative dielectric constant = 2.6, thickness = 0.8 mm, and dielectric loss tangent = 0.002) is chosen for the design. The size of the antenna is 40 mm × 35 mm. The L-shaped branch and the T-shaped branch can resonant at 5.8 and 2.45 GHz, respectively. Three PIN diodes which connect the T-shaped branch and L-shaped branch with the feeding line are used to switch the operating frequency. The DC feeding structure is on the back of the substrate which contains inductors to isolate the RF signal. The simulation results are shown in Fig. 2, it can be seen that the return losses at 2.45 and 5.8 GHz are -26.42 and -39.63 dB, respectively. The antenna has the advantages of small size, low cost, high gain, and simple structure.

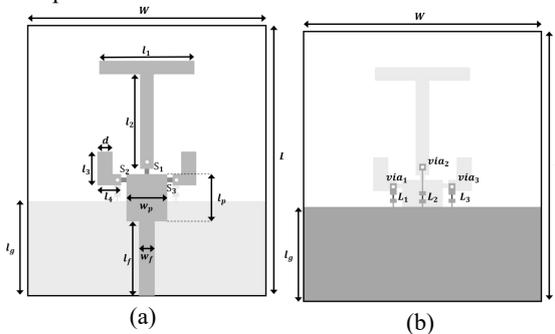


Fig. 1. Schematic diagram of frequency reconfigurable monopole antenna, (a) front (b) back

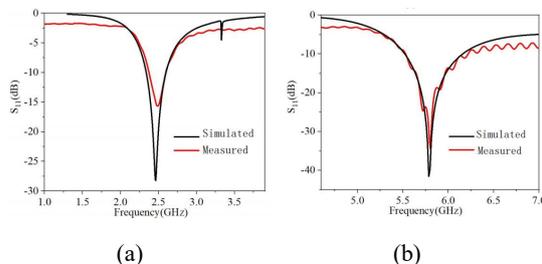


Fig. 2. |S₁₁| of frequency reconfigurable monopole antenna operating in different frequency bands, (a) 2.45 GHz (b) 5.8 GHz

Rectifier

An efficient dual frequency rectifier with a size of 36 mm × 26 mm is shown in Fig. 3. The rectifier adopts a Schottky diode BAT15-03W. In the impedance matching network, TL1 and TL2 can realize the conjugate matching at the frequencies of 2.45 and 5.8 GHz. In order to improve the power conversion efficiency of the rectifier, it is necessary to suppress the RF energy, and the DC-pass filter adopts two fan-shaped open-circuit branches. When the input power is 10 dBm and the load is 1100 Ω, the simulation and measurement results of PCE and |S₁₁| are shown in Fig. 4. The measured results fit well with the simulation results, and there is only a small frequency offset in the high frequency band. It is caused by the inconsistency between simulation and actual model parameters of rectifier diode at high frequencies. The simulated PCE can reach more than 70% over the frequency range of 2.36-2.53 and 5.56-5.91 GHz. In the corresponding frequency band, the measured PCE can reach about 70% and 50% respectively. The rectifier has the advantages of simple structure, large frequency ratio, high efficiency, low production cost and small occupied volume.

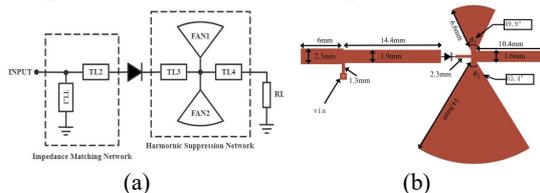


Fig. 3. The structure of the rectifier, (a) block diagram (b) layout

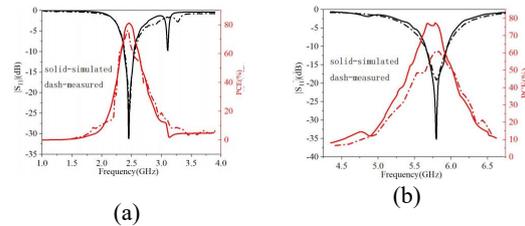


Fig. 4. Simulation and Measurement results of PCE and |S₁₁|, (a) 2.45 GHz (b) 5.8 GHz