ABSTRACTS (MASTER THESIS)

Study on the improvement of RF-DC conversion efficiency of microwave rectifiers with pulse modulation

(Graduate School of Engineering, Laboratory of Applied Radio Engineering for Humanosphere, RISH, Kyoto University)

Takashi Hirakawa

Introduction

Currently, the necessity of the Internet of things (IoT) technique is increasing. IoT requires a flexible configuration of sensor networks, which is hindered by wired- charging sensors. The microwave wireless power transfer (MWPT) can be the solution to this problem. Although MWPT enables integrating communications and battery-less motion of the sensor network, it interferes with communications and its charging efficiency is lower than the wired charging. So improvement of the transmission efficiency is very important for practical use of MWPT. MWPT has many loss components. This study focused on radio frequency to direct current (RF-DC) conversion efficiency of rectifiers. In former study, input waves which have high peak-to-average power ratio (PAPR) is effective for improving the RF-DC conversion efficiency of rectifiers. Pulse modulation can make higher the PAPR of input waves. So we studied about the rectifiers with pulse modulated input as shown in Fig. 1 in this thesis.

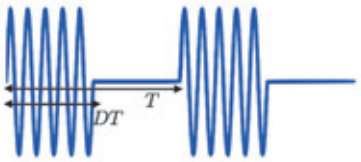

Figure 1. Pulse modulated wave

Circuit design and Experiments

We designed the single-shunt rectifier for continuous wave (CW) input which has 10mW input power and 2.45 GHz frequency. Figure 2 shows the designed circuit. As a load of this rectifier, the resistance and 100 uF capacitance are connected in parallel. Figure 3. shows the simulation and experimental results of RF-DC conversion efficiency with continuous input. In these simulations and experiments, we changed the average power and load impedance. This result shows the same tendency of all lines. Next, we experimented the RF-DC conversion efficiency of this rectifier with pulse modulated input. We changed the duty ratio of pulse modulated waves and load impedance. Duty ration *D* means the on-time to off-time ratio as shown in Fig. 1. In all cases the average power is fixed as 1 mW. Therefore, the peak power becomes the 1/*D* mW. Figure 4. shows the experimental result of RF-DC conversion efficiency with pulse modulated input. The smaller duty ratio is, the larger peak RF-DC conversion efficiency and optimum impedance become. Optimum impedance becomes 1/D times as that with continuous wave input. In addition, the peak RF-DC conversion efficiency with duty ratio equals to 1mW compete with that with 10mW continuous input. As a result, we can achieve the RF-DC conversion efficiency with low input using pulse modulation.

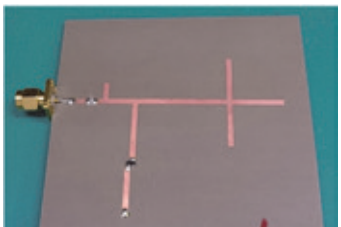

Figure 2. The designed and experimented circuit

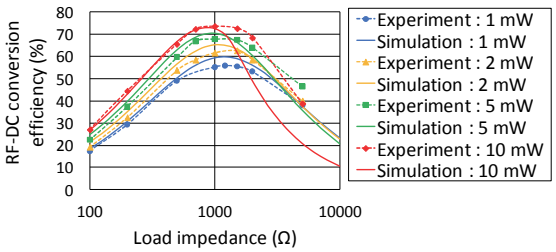

Figure 3. Experimental result of the rectifier with continuous input.

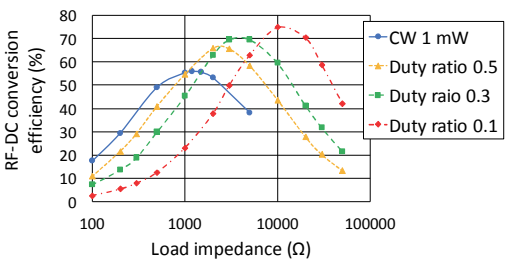

Figure 4. Experimental result of the rectifier with pulse modulated input.