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Power Conversion Efficiency of RF-DC Rectifier for RF Energy Harvesting

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Abstract—RF energy harvesting technology is strongly depended on the RF-DC rectifier circuit in the wireless power transmission. In this paper, we show the power conversion efficiency of developed RF-DC rectifier circuit for RF energy harvesting.

1. Introduction

Recently, the availability of free RF energy has increased due to advent of wireless communications and broadcasting systems. RF energy harvesting is the process of extracting small amounts of energy from the ambient environment. This energy can be used to power either portable electronic devices, such as wireless sensing nodes, mobile phones and medical devices, or to charge electrical storage devices (rechargeable battery or capacitor), which can be used at different time intervals for power applications. RF energy harvesting technology is strongly depended on the RF-DC rectifier circuit in the wireless power transmission. The RF-DC rectifier for converting microwave power to DC power has attracted considerable attention in the development of the wireless power transmission [1]. The application of this technology can be used in low power mobile devices, such as radio-frequency identification (RFID) and Zigbee. In this paper, we show the power conversion efficiency of developed RF-DC rectifier circuit for RF energy harvesting.

2. RF-DC rectifier

Figure 1 shows the manufactured RF-DC rectifier circuit. The rectifier circuit is a key element to improve the RF-DC conversion efficiency. A Schottky diode HSMS-2862 was chosen for the rectifying circuit. The inductor and microstrip line are used for input impedance matching circuit and the capacitors are used for the DC block capacitor and the DC filter capacitor. A 2.13 GHz RF-DC rectifier was developed using the previous developed rectenna of 5.8 GHz because the frequencies of 2.12 GHz and 2.14 GHz are the CDMA and WCDMA frequency bands, respectively [2].

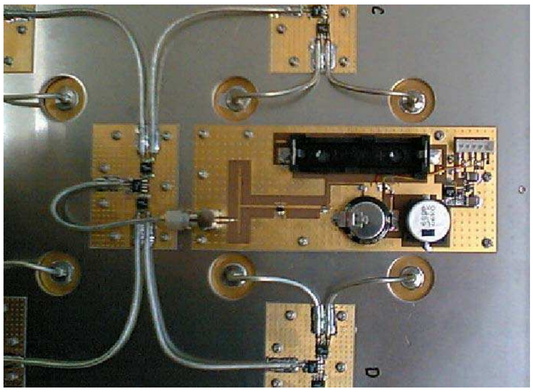

Figure 1: RF-DC rectifier.

3. Experimental Results

We setup the experiment of power transmission through wires to validate the performance of manufactured RF-DC rectifier circuit. A signal is generated by SMJ100A vector signal generator (ROHDE-SCHWARZ). In this test, the RF power is generated by 8dBm and 11dBm. The RF-DC conversion efficiency is calculated by

$$\eta = \frac{V_{out}^2/R_L}{P_{RF}} \qquad (1)$$

where V_{out} is the measured output DC voltage on the load impedance and P_{RF} is the RF power. Fig. 2 shows RF-DC conversion efficiency versus various input frequency. The vertical axis represents the conversion efficiency. The incident power was varied from 8dBm to 11dBm, and input frequency was varied from 2.1GHz to 2.171GHz. Note that the weaker incident power shows a poor conversion property. The conversion efficiency was improved significantly with increasing incident power. This means that higher incident power can increase the conversion efficiency. The conversion efficiency shows the best performance from 2.13GHz to 2.15GHz due to the load impedance as

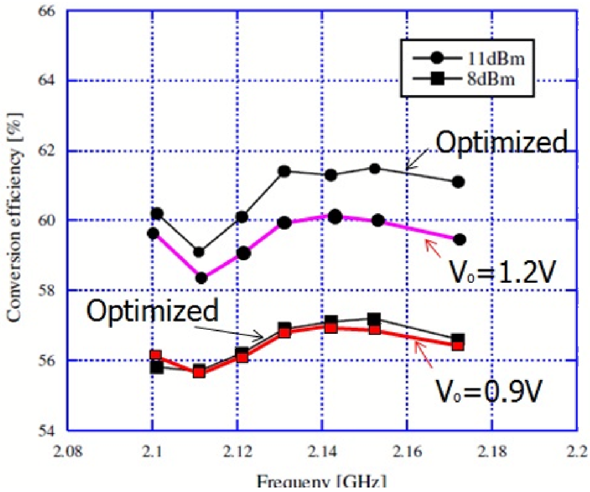

Figure 2: RF-DC conversion efficiency vs. various input frequency.

297.3 Ω. Due to the experimental results, we should consider the optimum load impedance with higher incident power case to maximize the RF-DC conversion efficiency.

4. Conclusion

From the evaluated results, it is found that the weaker the input power shows a low efficiency of the rectenna. Therefore, it is necessary to increase the input power for efficiency of the rectenna. Moreover, when we adjust the optimum load impedance with higher incident power case, it is possible to maximize the RF-DC conversion efficiency.

Acknowledgement

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