Design of High Efficiency and Low Power Rectifier Circuit for 920 MHz Wireless Power Transfer

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In recent years, constant monitoring systems for biological information using wearable devices have attracted attention in medical and welfare settings. Fig. 1(a) shows a schematic diagram of the system. As shown in Fig. 1(a), the health of wearers can be managed by acquiring their biological information using sensors in the wearable device and sending the data to a database. In this system, the wearable device needs to operate for a long time. Therefore, the weight of the battery of the device and the trouble of replacement are problems. As a method to solve the problem, low power wireless power transfer using 900-MHz band radio waves while transmitting biological information to a database has been proposed. One of the problems with the proposed wireless power transfer system is rf-dc conversion efficiency of the rectifier circuit. Generally, rf-dc conversion efficiency of a rectifier circuit decreases as the input power decreases due to nonlinear characteristics such as a diode. Also, when the input power is low, it is difficult to obtain the output dc voltage necessary for the operation of the sensor. In previous research, the rf-dc conversion efficiency of more than 80% was realized even at -12.5 dBm by a charge pump circuit using CMOS [1]. However, there is a problem that its output voltage is as low as several hundred mV. Furthermore, the rf-dc conversion efficiency decreases when multiple stages are used to obtain high dc voltage. To solve these problems, in this work, we design a low power rectifier circuit with high efficiency and high output voltage using single shunt rectifier circuit theory with Class-F load.

Fig. 1(b) shows the circuit diagram of the rectifier circuit designed in this work. ADS (Advanced Design System) was used for the simulation. The circuit board is NPC-H220A (board thickness 800 μm). The diode was HSMS2860. The frequency f_0, input power P_{in}, and the characteristic impedance of the line Z_0 were 920 MHz, 100 μW, and 50 Ω, respectively. The circuit was designed in the order of low-pass filter and output filter. After that, the line length of the matching circuit and each line was optimized so that the rf-dc conversion efficiency was maximized. As a result of simulating the circuit shown in Fig. 1(b), the rf-dc conversion efficiency was 73.2% and the output dc voltage V_{out} was about 1.1 V. From these results, it was shown that high efficiency and high output dc voltage could be realized by designing the rectifier circuit based on the single shunt rectifier circuit theory with Class-F load.

In this paper, only the simulation results are shown, but we plan to create and measure the circuit in the future. In the presentation, the results of the measurement will be presented.

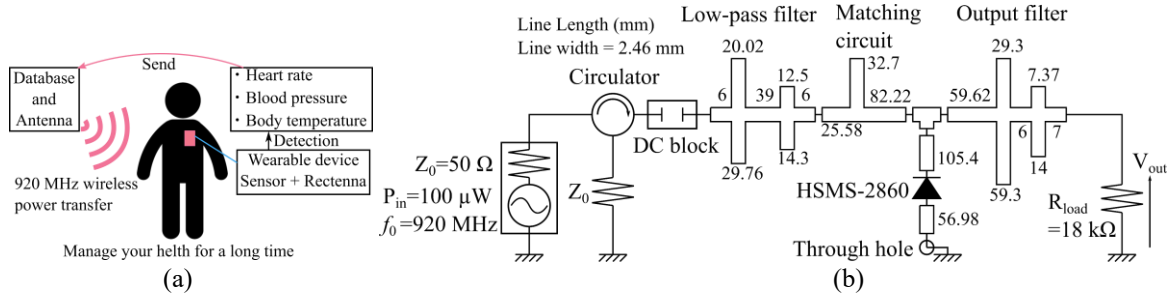

Figure 1. (a)Schematic of wireless power transfer system for wearable device, (b)Designed rectifier circuit

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References

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