ABSTRACTS (MASTER THESIS)

Study on Rectifier for a Satellite Internal Wireless Power Transfer System

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In order to achieve space development in future, it is essential to launch observation and scientific satellites. However, because rocket carrying capacity is limited, reducing the weight of an artificial satellite is an important issue. To solve this problem, an internal wireless system (IWS) for a satellite was proposed. If all the wires can be eliminated, its weight will be reduced by 20% to 30%, and the subsystems designs can increase without the limits of wires. During satellite operation, because subsystems is independent, the stability can also be increased. The wires of an artificial satellite can be divided into two types: signal wires and power wires. In a previous study, the signal wires were reduced with wireless communication devices. In this paper, we proposed a complete IWS system using wireless power transfer technology. The IWS we propose is a wireless power supply system that can be compatible with the internal wireless communication system as well. In this paper, we use a 5.8 GHz charge pump rectifier with high conversion efficiency. Moreover, we theoretically compare the conversion efficiency of a charge pump rectifier and a single shunt rectifier, and experimentally verified the results.

We analyzed the cause of loss in a rectifier circuit and the diodes' voltages and currents in a charge pump circuit. The conversion efficiency can be expressed as the difference from 100% efficiency caused by the transmission line loss, element loss and reflection. When the rectifier circuit is in the matching condition, the reflected component is small enough to be considered 0%. The total loss of a rectifier circuit is generated by the electronic elements. By analyzed voltages and currents of the diodes, however there are two diodes in a charge pump circuit, the diodes loss is the same with a single shunt circuit which is in the same conditions.

Using the results of previous, we designed and made the 5.8 GHz charge pump rectifier and measured its performance practically. In the circuit simulation calculations, the conversion efficiency reached about 77% at 1300 Ω optimum load. The experimentally measured efficiency of the circuit is about 71% at optimum load, which is consistent with the simulation results. Because of the limits of the experimental conditions, the design accuracy is 0.1 mm, which is one-tenth of the typical accuracy of high-frequency circuit design. If we can design and produce this circuit under better conditions, the conversion efficiency should reach about 80%. The highest conversion efficiency so far reached about 80% in a single shunt circuit. Therefore, the results of this experiment also prove that a charge pump circuit and single shunt circuit have the same conversion efficiency.

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