Design of a High Gain Shunt Rectifier for Wireless Power Transfer at 2.45 GHz

Robin Auriac, Esteban Hubert, Keisuke Konno, Hiroyasu Sato, Qiang Chen
Department of Communications Engineering, Graduate School of Engineering,
Tohoku University, Sendai Japan

I-Introduction

The purpose of this study is to design a high gain rectifier for wireless power transfer (WPT) that can work with high frequency (2.45GHz) and medium power input(17dBm). High gain rectifiers are crucial for the efficiency of a WPT system. This study tries to implement and optimize a rectifier using the Class-F Rectifier study of professor Jiapin Guo [1].

II-Design of the rectifier

The Shunts topology is selected because of its documentation, its compacity, and its small number of components. Moreover, in order to optimize the speed of the system response, a Schottky diode is selected. But, in the working frequency (2.45GHz), the number of the harmonic created by the diode will be a loss of energy. So, two stubs are added near the Schottky diode. These stubs have the purpose to cut the second and the third harmonics (length of $\frac{\lambda}{4}$ and $\frac{\lambda}{6}$). Then, in order to correct the imaginary part of the load impedance of the circuit, a stub is added near to the output port.

To qualify the pertinence of a layout, four requirements are defined and observed. The first is the gain of the circuit, defined as:

$$G = \frac{P_{dc}}{P_{in}}$$

Where the P_{dc} correspond to the DC power and P_{in} is fixed at 17dBm. The second is the reflection coefficient at the beginning of the circuit that needs to be under -10dB at the working frequency. The third is the output voltage that should be above 0.8V and the last is oscillation of the voltage that need to be negligible. So, the oscillation of the voltage does not excess 10% of the voltage.

III-Schematic hold and test

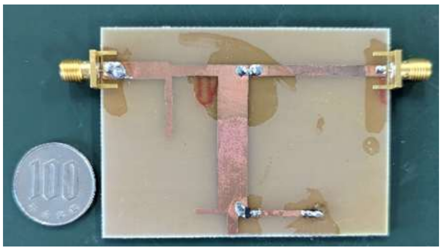

Figure 1 – Rectifier realized

After an optimization of the length and width of every line form the theoretical value (±0.1mm), the layout of the Fig.1 has been chosen. The simulation of this rectifier gives a gain of 50.9 %, an oscillation 5.9% and an average voltage 1.8V.

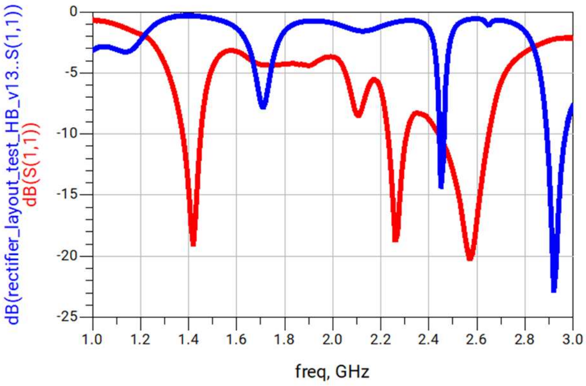

Figure 2 – Comparative of the input reflection coefficient (simulation in blue and measurement in red)

For the measurement, the rectifier is produced on FR4 dielectric and using chemical etching. During the test of the input reflection coefficient presents a frequency shift around the 200MHz (Fig.2) and a loss of 4dB compare to the simulation. Unfortunately, the DC voltage test is currently under 0.6V.

IV-Conclusion

The rectifier currently does not work as intended. The large difference between the simulation and the measurement could come from the incertitude production methods and position of the via that can impact the efficiency of the rectifier.

V-References

[1]-Jiapin Guo, Hongxian Zhang, Xinzn Zhu "Theorical Analysis of RF-DC Conversion Efficiency for Class-F rectifier", IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 62, NO. 4, APRIL 2014

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