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DESIGN AND APPLICATIONS OF HIGH EFFICIENCY RECTIFIERS FOR MICROWAVE WIRELESS POWER TRANSMISSION

Abstract

A microwave rectifier is one of the key components of a microwave wireless power transmission system. Microwave rectifiers are usually integrated with antennas to form rectenna, which receives microwave radiation and converts into DC for load. The conversion efficiency and power capacitance are two important aspects of microwave rectifiers. The MW-DC conversion efficiency affects the total efficiency of the microwave wireless power transmission system. In this paper, the GaAs Schottky diodes are applied to build high efficiency microwave rectifiers. A few microwave rectifiers at S band and C band are designed, fabricated and measured. The highest efficiency of a compact microwave rectifier, which contains a single diode in series, reaches 84% at S band. The diode is an industrial low-cost Schottky diode available directly on the market. Meanwhile, a Schottky diode array is applied to enhance the power capacitance of any microwave rectifier based on the design of a single diode circuit. The power capacitance of a compact microwave rectifier has been enhanced to 10 W level with a reasonable MW-DC conversion efficiency higher than 65% at S band. It shows a way to realize large power microwave rectifiers from conventional Schottky diodes. The measured temperature distribution shows the long time stability of the microwave rectifier, which may be applied to a much higher power level potentially. Moreover, microwave rectifiers at C band are built from a voltage doubler circuit and the MW-DC conversion efficiency reaches 65% as well. The microwave rectifier based on the voltage-doubler circuit shows a better dynamic range for either the DC load or the input microwave power. These microwave rectifiers have been applied to build rectennas, or a rectenna array, in different ways. The experiments on ground show a good performance, of which the microwave rectifiers can be applied to a microwave wireless power transmission system. A higher MW-DC conversion efficiency and power capacitance of a microwave rectifier are expected with the development of novel Schottky diodes, e.g. diodes from GaN or SiC. The conventional harmonic recycling mechanism for high efficiency microwave rectifier design will be advanced to present better microwave rectifier designs.