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Diode-based Rectenna for Microwave Ovens

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Since the first microwave oven with reasonable size and air-cooled was placed in the market, half a century ago, there has been little change to the power source of this widely used device. Nowadays, the microwave oven optimization is based on a liter of water, on how well can the oven heat this large and uncommon load. This optimization is then unrelated to the magnetron, the RF signal source, [1]. The main reason for that is the need for physical adjustments when optimizing the output signal of the magnetron, making it expensive and complex.

However, a new generation of microwave ovens is under development as a result of the ongoing evolutions in the field of solid state RF. High power transistors, capable of delivering power levels comparable to the magnetron, are some of the breakthroughs in the fields of RF engineering and communications that made RF cooking possible. This new technology is revolutionizing the oven industry for its ability to integrate heating algorithms, i.e. adjust the power source frequency, phase and power to adapt to each food.

Although magnetrons are now small and highly efficient and solid state ovens can control the power delivered to the food, neither can 'see' the electromagnetic field inside the microwave oven. A field detector probe is then proposed, based on a rectenna design, which consists of an antenna and a rectifier circuit, converting the RF signal inside the cavity to a DC voltage.

The power level of the radiating electromagnetic waves inside the microwave oven is extremely high, making typically used components unusable. Even with high power handling PIN diodes, the circuitry previous to the rectifying stage needs to mismatch the overall circuit to relax the components used to convert the RF energy to a DC voltage. With this in mind, the antenna is not matched, so only a certain amount of power is absorbed, and the matching network/bandpass filter at the input is now a mismatching network.

After the design and implementation of the field detector probe, a shielding box, to protect the circuit from the radiation inside the microwave, is built. This box is 3D printed, made of plastic and coated with aluminum. Only the antenna is left outside the box and the whole structure is then placed inside the microwave oven with two glasses of water. This setup can successfully read the different power levels inside the microwave oven, proving the standing wave pattern of the electromagnetic field, with DC voltages up to 100 mV.

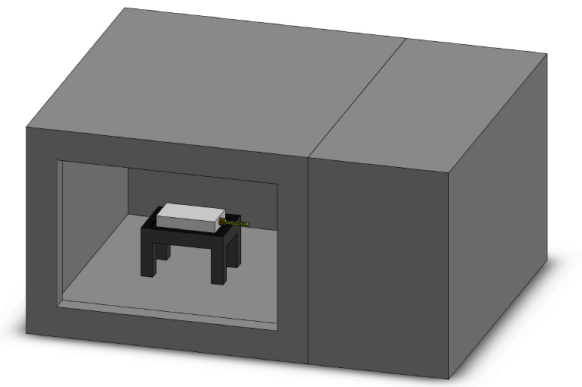

Figure 1. Microwave Oven Setup

1. R. Wesson, "RF Solid State Cooking White Paper," Ampleon, 2016, pp. 1-13.