SDC5 - 3D-Printed Rectennas for Energy Harvesting Applications

Detailed description and rules

Introduction

This Student Design Competition aims to introduce students to a rectifying antenna (rectenna) working at 2.45 GHz and its realization on 3D printable materials (such as PLA - polylactic acid, PVA - polyvinyl acetate, etc.) so that it can be worn due to materials' flexibility. This project will introduce students to the concept and implementation of efficient and low-cost wireless energy harvesters. The efficiency of the harvester, together with its dimensions, will be the criteria in selecting the winning designs.

Design specifications and rules

1. Any 3D printing technology may be used to realize the prototype, but the design must result from the students' effort.

2. The metallization can be realized either with hand-cut adhesive copper or with traditional electrodeposition techniques.

3. The use of commercially available components is allowed for the RF-to-DC rectification circuit.

4. The rectenna shall have no internal battery.

5. The prototype should have a DC output and a ground pin to facilitate the DC load voltage measurement. The pins should be in the form of two wires allowing the judges to attach them to the multimeter through banana clips.

6. A PTH resistor has to be employed as the load in order to be measured before connecting it to the DC output and the ground wires.

7. Contestants should provide a short video (max. 90 seconds) to describe the technique employed for designing their 3D-printed rectenna and demonstrate that the prototype has been actually fabricated with commercial 3D printers and materials (see the examples in Figs. 1 and 2).

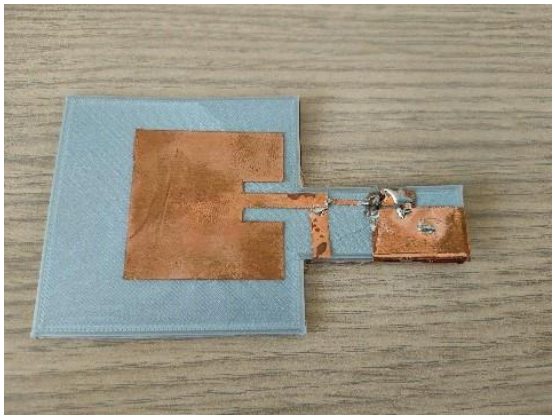

Figure 1. 3-D printed rectenna realized with adhesive copper and PLA.

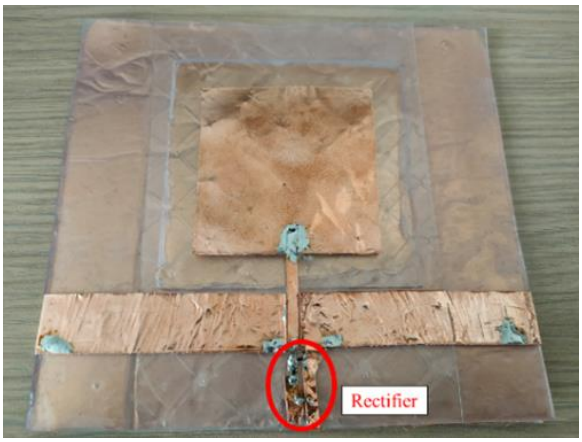

Figure 2. 3-D printed rectenna realized with adhesive copper and Flexible 80A material.

Evaluation process

Testing and judging the harvesters will be performed on-site at the 2023 International Microwave Symposium in San Diego, California. At least one member of one participating group must be present at the testing to assist with the evaluation. Only one prototype per participating group is allowed.

A linear polarized antenna working in the 2.4 GHz band will be placed as a source at a distance of 1.5 m from the rectenna under test (same height for the antenna phase centers), and a Figure of Merit (*FoM*, see below) will be measured to score a design.

Scoring

The numerical score is given with the following *FoM*, which takes into account the RF-to-DC efficiency of the whole rectenna and its overall dimensions:

$$FoM = 10\ log_{10}\left[\left(\frac{P_{DC}(\mu W)}{1(\mu W)}\right)\cdot 100 \Big/ \frac{D_1(cm)\cdot D_2(cm)\cdot T(cm)}{1\ cm^3}\right]\ (dB)$$

Where $P_{DC} = V_{OUT}^2/R_{LOAD}$ is the DC power consumed by the load. D_1 and D_2 are the total length and width of the prototype, while T is the total thickness of the prototype.

The winners are the designs with the highest *FOM*s.

Name and number of supporting MTT-S Technical Committee

TC-25 – “Wireless Power Transfer and Energy Conversion”

TC-28 – “Biological Effects and Medical Applications Committee”

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