Student Design Competition
for IMS2018 in Philadelphia, 10-15 June 2018

Title of the Student Design Competition:

Wearable Microwave Energy Harvesting Design Competition

Organized by the MTT-26 WIRELESS ENERGY TRANSFER AND CONVERSION

Sponsors:
MTT-26 Wireless Energy Transfer and Conversion
MTT-10 Biological Effects and Medical Applications
MTT-20 Wireless Communication

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Introduction:

Competitors are required to design, construct, measure, and demonstrate a wrist wireless energy harvester (in the following referred to as WEH) at 2.45 GHz capable of driving a small electronic device. This project will introduce students to the concept and implementation of efficient and wearable wireless energy harvesters. The efficiency of the harvester when worn on the wrist and the novelty of the design will be the leading criteria in selecting the winning design. Testing and judging of the harvesters will be performed at the 2018 International Microwave Symposium held in Philadelphia, Pennsylvania. A member of the design group must be present at the testing to assist with the evaluation.

The winner of the competition will be recognized at the Student Awards Luncheon at the 2018 International Microwave Symposium. Faculty members are encouraged to introduce this as a project for their students in order to acquaint them to system and circuit level design.

This competition is sponsored by the technical committee on Wireless Energy Transfer and Conversion (MTT-26), Biological Effects and Medical Applications (MTT-10) and Wireless Communication (MTT-20).

Prizes

This will be a single-level contest with an amount of $2000 to be divide among the 3 first best designs. The teams that will demonstrate the best & Original performance will be given the opportunity to publish a common paper describing their designs in microwave magazine.

Wireless Power Transmission (WPT) Design Competition Rules

1. Any technology may be used for the design, but must be the result of student effort.
2. Use of commercially available components is allowed.
3. The demonstrator (Wireless Energy Harvester, WEH) shall allow for internal inspection by the judges.
4. The WEH shall be able to efficiently harvest a power density ranging from 1μW/cm² to 10μW/cm² at 2.45 GHz (linear polarization). The WEH will be fixed on a thin plastic tube of 5cm diameter, filled with a phantom that mimics the body tissues. This setup aims at simulating a WEH fixed on a human wrist. The phantom will consist of bags of saline water comprised of 0.4% NaCl + 99.6% DI water (the percentage is by weight) resulting in a dielectric constant of around 81 (Tolerance in NaCl concentration on the day of the competition will affect the effective dielectric constant)
5. The maximum weight of the WEH should not exceed 50 grams.
6. The WEH should fit in a Hollow cylinder (5cm of inner diameter and 5.8cm of outer diameter)
7. The WEH shall have no internal battery.
8. The WEH output power shall be calculated as the total DC power delivered to a load RL that will be chosen by the competing team. The load should NOT be soldered to the WEH. The load has to be detachable in order for the judges to measure its value at DC. The DC power, PL, will be obtained by measuring the DC voltage (VL) across the load and calculating VL2/RL. Note that different orientations of WEH antennas may present different DC powers at the receiving location. The DC power will be taken from the receiver orientation set up by the design team in its stand-alone position (when held by stand, not by hand).
9. The WEH receiver should have a DC (VL) and ground (GND) pin to facilitate the DC load voltage measurement. The pins should be in the form of a header or TWO wires allowing the judges to attach banana clips. The measurement will be performed using a pair of clips which will NOT be considered when measuring the overall size of the WEH.
10. The WEH shall derive its energy from the wireless energy source only. It may not contain any solar cell, chemical cell, vibration cell, etc. The judges may measure the DC power at the receiver load when the wireless source is not turned on, deduct the DC power obtained from the DC power obtained when the wireless source is turned on, and consider the difference as the power PL(uW) harvested by the WEH.
11. Testing and judging of the harvesters will be performed at the 2016 International Microwave Symposium. A member of the design group must be present at the testing to assist with the evaluation. Only one prototype per participating group is allowed.
12. Contestants should prepare a small poster (A3 size) describing the specificities of their prototype and their designing experience: the tradeoff they have been facing and justifying their choices. They should be able to answer the judge's questions regarding the design.
13. A judge cannot assign a grade to a design originating fully or partly from its university.
14. Few tuning minutes are given to each teams prior the measurement perform by the judges. Each official measurement will be done once. No tuning is allowed after the official measurement is conducted. The decision of the judges shall be final.
15. Typical judging measurement setup may be reproduced at the team's institution using a radiating linear antenna on a wooden (or plastic) table about 3 ft above ground with the WEH receiver in direct line of sight with the source. The setup can be easily calibrated using a spectrum analyzer and a $\lambda/4$ antenna at the position of the WEH.

EVALUATION CRITERIA

The efficiency figure of merit (EFoM), to be used as the judging criteria, will be the DC output power PL(uW) (normalized over 1 uW), divided by the area (calculated as the product of the two largest dimensions D1 (cm) and D2 (cm) of WEH device and normalized over 10 cm2):

$$\text{EFoM} = 10 * log10\left[\left(\frac{P_L(uW)}{1(uW)}\right)^2 \Big/ \left(\frac{D_1(cm)D_2(cm)}{10(cm^2)}\right)\right](dB)$$

$$P_L(uW) = \frac{V_L^2}{R_L}$$

For example, a rectenna which harvests 1uW, and covers an area of 10 cm2 has a figure of merit EFoM = 0 dB.

The winning design will be the one possessing the largest efficiency (EFoM).

Additionally the judges will assign the coils a grade based on their designing process. Contestants should prepare a small poster (A3 size) describing the specificities of their prototype and their designing experience: the tradeoff they have been facing and justifying their choices. They should be able to answer the judge's questions regarding the design.

Distance/transfer efficiency and the grade will be summed up to provide the final mark that will be used to designate the winning design