



## 2016 IEEE AP-S Student Design Contest: RF Power Scavenger

Travel to the 2016 IEEE AP-S USNC-URSI and win up to US \$1500!

Join the 7<sup>th</sup> IEEE Antennas and Propagation Society (AP-S) Antenna Design Contest! Design and build a power-scavenging device that can harvest and convert ambient radio-frequency emissions into useful DC power. The top 3 teams will receive up to US \$2,500 in travel funds to attend the IEEE Antennas and Propagation Symposium in San Juan, Puerto Rico, June 25 – July 2, 2016 to demonstrate their working systems. From these 3 teams, 1st, 2nd and 3rd place winners will be announced at the 2016 IEEE AP-S Awards Banquet at the conference and will receive cash awards of US\$1500, \$750 and \$250, respectively. Moreover, final reports will have the opportunity to be considered for publication in the IEEE AP Magazine. Important deadlines are **November 2, 2015** and **March 21, 2016**. The final version of this call will be posted on the APS/URSI 2016 web site, <http://www.2016apsursi.org>.

**Goal: Design and build a power-harvesting device that can convert ambient radio-frequency (RF) emissions into useful DC power.**

### Specifications:

- The frequency range(s) covered by the antenna is (are) your choice.
- Apart from the design of the antenna, a complete design should include devices for converting RF signals to DC power. An energy storage device (such as a capacitor) is important but optional (see below).
- The system should be as small and portable as possible. The maximum device size, including all components, should be less than 50cm x 50cm x 50cm.
- The following test scenarios at IEEE APS2016 will be employed, *excluding any energy storage device*:
  1. Ambient RF emissions are converted to DC power by the device. DC power is delivered to a resistive load of your choice and the DC power delivered to the load is measured. Any DC power required (e.g. biasing power) will be subtracted from the delivered power.
  2. The antenna portion of the device will be connected to a spectrum analyzer via a single SMA connector to determine the available input power and efficiency of the RF-to-DC conversion and bandwidth.
- Merit will be assigned to designs based on the following criteria, equally weighted:
  - Available input power and DC power delivered to the load (net efficiency)
  - Bandwidth of the power-harvesting antenna, measured using a network analyzer (300 kHz–60 GHz)
  - Size and mass of the overall solution
  - Proposal of an energy storage device in the final report and presentation, and anticipated electrical performance with the harvester. Realization of the energy storage device is optional, and will not be tested.
- Existing licensed software at the university (e.g., electromagnetic simulation software) or free software may be used. Any other commercial software used for the project should be included in the budget. The total production cost for the entire system must be less than US\$1,500.

### Eligibility:

The team should consist of 2 to 5 students, with at least 50% being undergraduate students. For a 5-year Bachelorcum-Master degree program, students in years 1 to 3 are considered undergraduates. Each team should be advised by a professional mentor who is a member of the IEEE AP-S, but the work needs to be done primarily by the

students. No student or mentor should be involved in more than one team.

### **The Application and Review Process:**

1. All applicants must submit a preliminary design by **November 2, 2015**. It must include:
  - a. A proposal limited to two pages and in 12-pt Times New Roman font that includes
    - i) A detailed description of the system to be built.
    - ii) The steps that will be taken to ensure the accuracy of the system.
    - iii) A bill of materials (up to US \$1,500).
  - b. A letter from a professional mentor, such as a professor or engineer in industry indicating agreement to supervise the project (the students being mainly responsible for doing the work). The mentor must be an AP-S member (please provide IEEE membership number) and must verify that all team members are graduate or undergraduate students at a university, college, or technical school. The proposal and letter must be integrated into a single pdf file named TeamName.pdf.
2. The AP-S Education Committee will assess each preliminary design based on likelihood of achieving the design goal and specifications, creativity, and quality of written materials. Six semi-finalist teams will be selected by **November 16, 2015** and will receive US\$1,500 each to build and test their designs.
3. Each of the six semi-finalist teams must submit their final design by **March 21, 2016** in the form of a video demonstration of the working system ( $\leq 5$  minutes), and a final report ( $\leq 8$  pages) in pdf format ( $\leq 5$  MB file size). Submission instructions for the video demonstration will be provided later (some videos from previous contests are available on Youtube – search for “AP-S Student Design Contest”). The report should follow the two-column format of the IEEE Transactions on Antennas and Propagation and include:
  - i) A detailed description of the system (including schematic and other diagrams).
  - ii) A list of parts and materials required, including where to obtain them and costs.
  - iii) Photos of the final system (including a scale to show how large it is).
  - iv) Assembly and operating instructions for the system.
  - v) Measurements obtained using the system for the specified test scenarios.
  - vi) Biographies (100 words or less each) and photos of all design team members.
4. Several Design Contest Judges will be appointed to assess each semi-finalist’s design based on achieved performance, creativity, completeness of the description, functionality of the system as determined by the video, and quality of written materials. Three finalist teams will be selected by April 18, 2016 to receive stipends of up to US\$2,500 per team to travel to and attend the IEEE AP-S Symposium. The stipend is intended to cover equipment shipping costs and all expenses for one team representative; however, it may be divided among multiple team members.
5. The finalists will be expected to demonstrate their working systems during the Symposium and attend the Awards Banquet. Two banquet tickets will be reimbursed per team, for one team member and the team mentor. Each team should bring all necessary equipment for the demonstration. The received power will be measured for the test scenarios using the same experimental setup. The Design Contest Judges will assess the final demonstrations and take into account the final reports to select the 1st, 2nd, and 3rd prize winners, who will receive certificates and cash prizes of US\$1,500, \$750 and \$250, respectively. The prize winners will be announced at the Awards Banquet.
6. After the Symposium, the finalists may revise their final reports for possible publication in the IEEE AP Magazine under the Education Column (the reports will be reviewed and must meet Magazine standards). Team mentors may either be listed as a co-author or acknowledged in the paper.

### **How to Submit Materials:**

Send all materials to [designcontest@ieeeaps.org](mailto:designcontest@ieeeaps.org) with the subject line “2016 IEEE AP-S Design Contest Submission.” Questions may be sent to the same address. All submitted materials must be in PDF format according to the guidelines above.