## Student Design competition 2017

Three thrusts will be offered for the SDC at the EuMW 2017.

Thrust 1: Transceiver Design

Thrust 2: Power-amplifier for the Internet of Things

Thrust 3: Rectenna

The thrust 1 is a pure on-site competition within the Doctoral School and the Student School. Everything will be performed on-site.

Thrusts 2 and 3 are to be prepared before the conference and the results/devices presented at the conference in Nuremberg.

For Thrust 2 and 3 the participants should:

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| * Submit an entry form to sdc@eumw2017.com by 1 September 2017 giving names and affiliations.
* Provide a support letter by your professor stating that you are working on this project and that at least one person will be able to join EuMW 2017.
* Sponsoring professors are encouraged to introduce this competition as a course project for their students in order to acquaint them to system and circuit level design.
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| * A short description of the devices is to be provided with the application. A schematic of the circuit shall be brought to the EuMW.
* All devices shall be accessible for inspection on-site.
* Participants are required to attend EuMW the full Wednesday: The presentation of the winning team is on Thursday in the closing session.
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## Thrust 1 Doctoral School Thrust: Transceiver design

The competitors are required to design, construct, measure, and demonstrate a 16 QAM wireless transmitter at 1 GHz. Working in teams, students will develop all of the components for a 16 QAM transmitter and operate from a simple 9V battery. Each component will be entirely designed, simulated, and built on-site. The teams will then assemble a complete radio from their components that will be tested for its linearity EVM (error-vector-magnitude) behaviour. The transmitter design, testing, and judging of the transmitter will be performed during the European Microwave Week 2017 in Nuremberg. **You need to be registered for the Student School or Doctoral School in order to participate this thrust.** The participants need to bring nothing but their interest in microwave design and their laptop running a windows OS and capable of installing software (admininstrator privileges). All Materials and design tools are free and included as part of the doctoral school thanks to our sponsors listed on the site.

The device with the highest FOM will win a prize.

## Thrust 2: Power Amplifier for the Internet of Things (IoT)

Competitors are required to design, construct, measure, and demonstrate a wireless power amplifier at 2.45 GHz capable of an output power P-1 dB of 20 dBm to be built **before** the conference.

The amplifier shall be implemented in a platform/module, so that it can be measured on-site. Efficiency as defined in the rules will be the leading criteria in selecting the winning design. Testing and judging of the power amplifiers will be performed during the European Microwave Week 2017 in Nuremberg.

# Power Amplifier Design Competition Rules

* Any semiconductor technology may be used for the design, but must be the result of student effort.
* Use of commercially available components and subsystems is allowed.
* The design shall allow for internal inspection of the circuitry by the judges.
* The overall size of the platform shall not exceed 20 × 20 × 5 cm³.
* The RF connector shall be SMA with a female connector at both ports.
* The impedance at both ports should be 50 Ohm.
* The design shall derive its energy from a maximum of one DC source. It may not contain any battery, solar cell, chemical cell, vibration cell, or other internal source.
* The amplifier should have one DC (VDD/VCE) BNC connector on a cable of minimum length of 1 m.
* The maximum allowed DC voltage is 28 V.
* The amplifier should provide a stable RF behaviour.
* Testing and judging of the amplifier will be performed at the European Microwave Week 2017.
* A member of the design group must be present at the testing to assist with the evaluation.
* Only one amplifier design per participating group is allowed.
* The design must be presented at the beginning of the competition and no changes are allowed after this submission.

# Evaluation Criteria

* The design will be tested with a two-tone signal with 0 dBm of input power at 2.45 GHz and 2.46 GHz.
* The power amplifier should provide a gain of 20 dB when excited with a single tone of 0 dBm at 2.45 GHz.
* When excited with a two-tone signal of 0 dBm at each tone, the design should provide a minimum C/I (carrier-over-intermodulation ratio) of 30 dB (upper tone and lower tone).
* If the third-order intermodulation products IM3 (upper/lower tone) differ by more than 2 dB, the more unfavourable value will be taken in the sense given below.
* The resulting PAE will be measured and calculated.
* For the FOM the following number will be used: (C/I (in dB) as measured) \* (the PAE under this drive (in %) under these conditions).
* The device with the highest FOM will win a prize. In the unlikely event of identical FOMs for the leading teams, the device with the highest PAE will win.

## Thrust 3: Rectenna Design Competition Rules

Competitors are required to design, construct, measure, and demonstrate a wireless energy harvester at 2.45 GHz capable of driving a small electronic device (output power 10 µW). The harvester shall consist of an antenna and a rectifying circuit (rectenna) and shall be built before the conference. Harvesting efficiency as defined in the rules will be the leading criteria in selecting the winning design. Testing and judging of the harvesters will be performed during the European Microwave Week 2017 in Nuremberg.

# Rectenna Design Competition Rules

* Any technology may be used for the design, but must be the result of student effort.
* Use of commercially available components and subsystems is allowed.
* The design shall allow for internal inspection of the circuitry by the judges.
* The design shall derive its energy from the wireless energy source only. It may not contain any battery, solar cell, chemical cell, vibration cell, etc.
* The rectenna should have a DC (VDD) and ground (GND) pin to facilitate the DC load voltage measurement.
* A 100 kΩ resistor will be connected to the output of the rectifier. The rectenna needs to have a stacking strip with two 2.54 mm spaced connectors on the backside of the rectenna (the measurement resistor might be mounted to a small PCB).
* A wireless source operating at 2.45 GHz will be located in the competition room. The polarisation of the source is linear.
* The maximum distance at which the rectenna harvests a DC power of 10 µW will be measured.
* The rectenna must have its own stand, if needed, so that it can be placed (in proper orientation) on the flat test table by itself. Holding the rectenna by hand is not allowed during testing.
* Testing and judging of the rectenna will be performed at the European Microwave Week 2017. A member of the design group must be present at the testing to assist with the evaluation.
* Only one rectenna design per participating group is allowed.

# Evaluation Criteria

* The design which achieves an output power of 10 µW at the longest distance normalized to an antenna area of 10cm² between the source and the rectenna wins the contest.
* d = d10uW ∙ 10cm²/A
* The device with the highest FOM will win a prize.