# Backscatter Radio Student Design Competition

## Sponsoring MTT-S Technical Committee

MTT-24 (RFID Technologies)

## Coordinators

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## Competition Description and Rules

This competition requires participants to design, fabricate and test a backscatter modulator, which is a fundamental block of Ultra-High-Frequency (UHF) Radio Frequency IDentification (RFID) transponders. In an RFID system, the reader transmits a continuous wave signal, while the transponder reflects the signal and introduces a modulation, so as to convey its information.

The device under test (DUT) should consist of an antenna and a binary backscatter modulator (i.e., based on binary amplitude shift keying, BASK, or binary phase shift keying, BPSK), which should be optimized to achieve low-power consumption and maximum sensitivity in the proposed scenario. The system should operate in the RFID UHF band and will be evaluated with a 915MHz sinusoidal continuous wave signal.

### Setup:

The validation setup is composed by one reader and one tag (see scheme below for reference).

The reader transmits a sinusoidal signal with a frequency of 915 MHz.

One transmitted power scenario is considered: $P_{TX}$ = 25 dBm EIRP.

Two antennas are utilized for the reader, one for the downlink and one for the uplink (bistatic configuration). Both of them are co-located on the same table and aligned with the center spot of the metal plate. The transmitting (TX) antenna is connected to a signal generator, the receiving antenna to a spectrum analyzer.

The DUT is placed at a 2 m distance from the reader. The antennas of the reader are linearly polarized.

The tag is composed by the DUT, a waveform generator to generate the modulation signal and a driver to interface the modulation signal to the backscatter modulator. The input signal of the driver is the output of the waveform generator and the DUT has one port (wires) which allows it to be connected to the driver.

The design can be performed by using any technology. Use of commercial components is allowed.

Neither on-board batteries nor energy harvesting systems are allowed.

The DUT must have a maximum dimension of 5x5x2 $cm^3$, including both the substrate and any soldered components. Maximum weight: 10 grams.

The DUT is placed above a table and it will have to be mounted on a vertical metal plane. The metal plane is 1 m x 1 m. Participants are required to center their prototype around the marked positions.

> *Note 1: The metal plane can be realized by a dielectric (e.g. cardboard, styrofoam, etc) covered with aluminum foil.*
>
> *Note 2: The prototype can be mounted with double-sided adhesive tape. Tape strips can be stacked if needed, but the total stacked tape thickness cannot exceed 2 mm.*

The waveform generator generates a square wave with a frequency $f$=1 $MHz$.

The 0-to-peak voltage of the output of the driver(s) can be chosen by participants in the range [0.8-3.6] V. The utilized driver is the single buffer SN74AUP1G34 (single-ended square wave).

The overall power consumption of the DUT, $P_C$, is evaluated by measuring the power consumption of the driver (i.e., $P_C = V_{DD} \times I_D$). The current consumption of the driver is calculated as the average current consumption during a continuous modulation operation.

## Evaluation Criteria

The performance of the DUT are evaluated as a trade-off between the design geometries, the sensitivity and the power consumption in the aforementioned transmitted power scenarios. Evaluating criteria (figure of merit, FOM):

$$P = \frac{P_{RX1}(nW) + P_{RX2}(nW) + P_{RX3}(nW)}{P_{C1}(\mu W) + P_{C2}(\mu W) + P_{C3}(\mu W)}$$

$$FOM = P \times \frac{50}{D1(cm) \times D2(cm) \times D3(cm)} \times \frac{10}{weight(g)}$$

where $P_{RXi}$ is the power associated with the first side-band signal measured by the spectrum analyzer (i.e. power at 916 MHz) and $P_{Ci}$ is the power consumption of the driver, corresponding to the transmitted power $P_{TX}$ and the marked position $i$, and D1, D2 and D3 are the sides of the brick circumscribing the prototype.

Participants are also required to prepare 2-4 slides to describe their activity. Design innovation and quality of presentation should be at a level comparable with IEEE Microwave Magazine.

## How to Participate

Entry forms must be submitted before the 1st of April 2019.

An abstract with the description of the intended design, including a detailed estimate of the power consumption of the circuit, must be submitted before the 15th of May 2019.

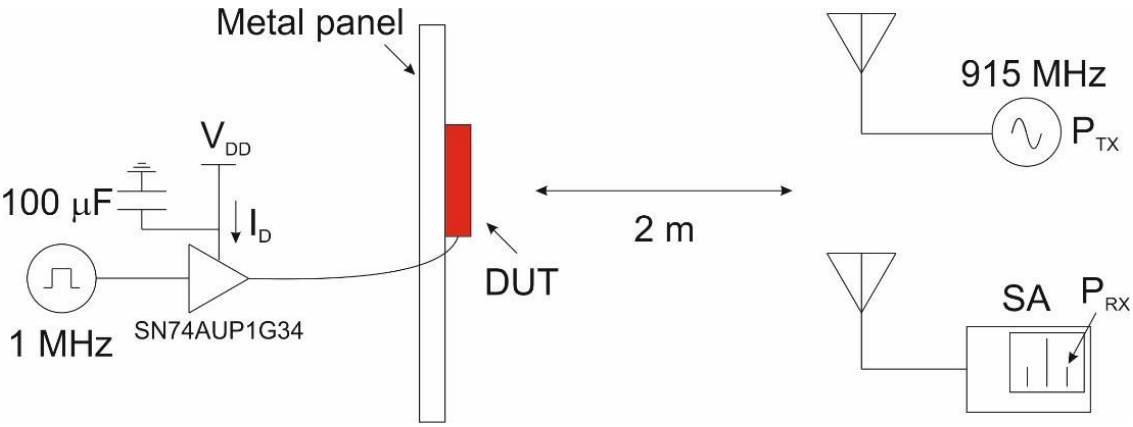
## Awards

First prize: $1000 and the possibility to publish a paper on IEEE Microwave Magazine

Second prize: $600

Third prize: $400

## Measurement Setup:



**Mounting Metal Sheet:**