Your TC number and name of your TC:

- TC-23 (Wireless Communications)

Primary contact name(s), email address, and phone number (of host or competition leader(s)):

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The title of your Student Design Competition:
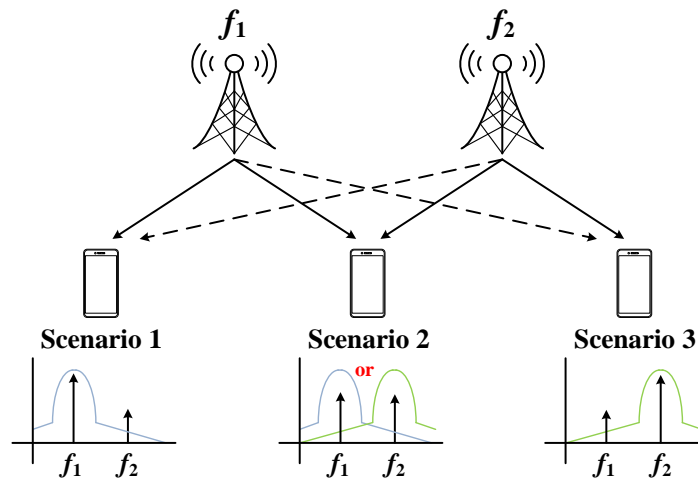
Spectrum Sensing Radio Receiver

Figure 1. Configuration of the spectrum sensing function.

Short Abstract or Summary Describing the Competition:

The ever developing of multi-standard wireless communications lead to a congest frequency spectrum. To improve communication quality and data transmission speed of wireless communication device (mobile phone, etc.), the cognitive radio receiver is proposed with adaptive and intelligent radio technology that can automatically detect and choose optimum channels and change operation parameters accordingly. They also have the ability to avoid the interference of adjacent channels.

This competition is aimed to design a simplified version of the cognitive radio receiver. Design entries will be judged based on the received data-rate, adjacent channel rejection, error vector magnitude (EVM) and power consumption of the receiver.

Which prizes will you offer and will this be a one level competition with all students combined or a two-level contest so that undergraduates are judged separately from graduate students?

The total prize money budged is $2000 per contest: the first-place winner will receive $1200, the second-place will receive $500, and the third-place will receive $300. The judges reserve the right to change this allocation based on the number and quality of the entries, possible tied scores and other unforeseen scoring situations.

This will be a one level competition.

Brief description of competition and rule(s). Make this as long as you want.

The objective of the project is to design a low-power high-speed receiver with spectrum sensing function. The receiver will receive two different signals from the signal generator and establish the communication with the signal generator. The receiver will operate under the following strict conditions:

- Transmitter (provided by the organizers on site): it sends two transmitted signals with one at 5.0 GHz and the other at 5.5 GHz and their modulations are at least 16 QAM.
- Digital data rate: should be at least 100 Mbps: the higher the higher scores.
- Output power of the receiver: it should be at least 0 dBm.
- Output IF frequency of the receiver (if any): it should be 500 MHz.
- The longest dimension of the antenna used: it should not exceed 10 cm (connector not included).
- Number of the antennas used in the receiver: the receiver should have only one antenna and no array.
- Off-shelf commercial components or devices: they are allowed.
- Power supply: the receiver should have no internal battery but external four channels DC power supply (0-20 V, 0-3 A); the power supply will be provided by competition organizers on the spot.

If a design entry or submission of the above spectrum sensing receiver does not meet any of the above conditions, the submission will be disqualified, and the tests will not be conducted.

The test setup is shown in Figure 2. The following parameters will be tested and measured during the competition.
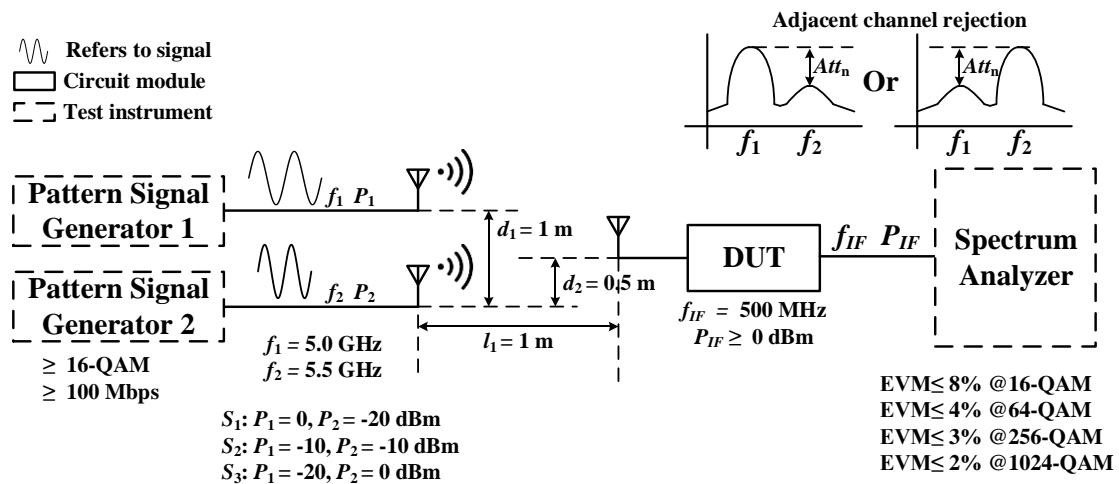

Figure 2. The test setup.

The output port of the receiver must be a female SMA connector in order to be connected to the spectrum analyzer. Two signal generators (considered as the transmitter), a spectrum analyzer, a metered power supply (0-20 V, 0-3 A), and a digital multi-meter will be available on-site for the measurement. The receiver is to be placed between the signal generator (transmitter) and the spectrum analyzer (receiver) to exam its performances. The setup is shown in Figure 2 ($l_1 = 1$ m, $d_1 = 1$ m, and $d_2 = 0.5$ m). The student competition participants should bring their designed receiver to the IMS competition hall for measurement. The signal generator, the spectrum analyzer and the power supply will be provided by the organizers on site for the measurement.

The measurements will be conducted as follows:
1) The two transmitted signals are fixed at 5.0 GHz and 5.5 GHz, respectively;
2) The power of two transmitted signals (P_1 and P_2) will vary and form three scenarios, i.e., $P_1 = 0$ dBm with $P_2 = -20$ dBm, $P_1 = -10$ dBm with $P_2 = -10$ dBm, and $P_1 = -20$ dBm with $P_2 = 0$ dBm, respectively.

3) Under each of the three scenarios, the maximum transmission data-rate in Mbps (R_{b1}, R_{b2}, and R_{b3}), the DC power consumption in mW (P_{dc1}, P_{dc2}, and P_{dc3}), and the adjacent channel rejection in dB (Att_1, Att_2, and Att_3) will be measured. They will be used to score a receiver.

Note:
1. The receiver is expected to detect the stronger transmitted signal and establish the communications with the stronger transmitted signal and ignore the weaker transmitted signal.
2. The locations of the antennas connected to the signal generators and the receiver are defined as locations of the transmitter and the receiver, respectively.
3. To keep the competition length within a reasonable amount of time, students will have maximum 10 minutes to tune their system before their test or measurements. Once the measurements start for each design, no tuning is allowed.

The Scoring:
The following formulas are used to score each designed receiver:
$$S_n = \frac{Att_n \times R_{bn}}{P_{dcn}} \quad (n = 1, 2, 3),$$
$$S_{total} = S_1 + S_2 + S_3$$

The team with highest scores will win the prizes!

Presentation:
The participating teams will be asked to give a 10-minutes oral presentation to the students and judges before the test starts.