

## Radio Lab

1. **DESCRIPTION:** Teams must construct an antenna prior to the tournament that is designed to transmit the maximum power at 2.4 GHz to a receiver 5 m away. Students must also complete a written test on the principles of antennas and electromagnetic wave propagation.  
**A TEAM OF UP TO: 2 EYE PROTECTION:** No **IMPOUND:** Yes **APPROX. TIME:** 50 Minutes
2. **EVENT PARAMETERS:** More information is available event page at [www.soinc.org](http://www.soinc.org)
  - a. Competitors must bring their antenna and may bring any notes, parts/supplies, or any type of calculators for use during any part of the competition. Notes of any kind must be 3-hole punched and secured in a 3-ring binder of any size, so that regardless of orientation nothing falls out.
  - b. Event supervisors must supply a transmitter that supplies a 2 mW, 2.4 GHz, 802.15.4 encoded signal to an sma-f connector that is mounted through a 30 cm x 30cm x 0.5 mm metal sheet as well as a linked receiver unit that can display the received power in dBm with at least - 80 dBm sensitivity. It is recommended that supervisors use a wifi-enabled laptop with inSSIDer v2.0 and the Simple Network Analyzer software, available on the Wisconsin Science Olympiad webpage.
  - c. Event supervisors must provide a 3.1 cm monopole antenna for to set the threshold dBm value.
  - d. The team's antenna, parts and any supplies (tools, notes, plots, etc.) must be impounded before the event starts. Appeals by teams must not be processed after they remove their device from the competition area unless the appeals committee has released it. Calculators need not be impounded.
  - e.
3. **CONSTRUCTION:** The device must fit within a 10.0 cm x 10.0 cm x 10.0 cm cube during all points of the competition and cannot be student-supported during testing (it must be free-standing).
  - a. The device must include an sma-m connector that can be easily connected to the sma-f connector on the event-supervisor-provided transmitter.
  - b. The device may be constructed of and contain any materials except for commercial antenna parts and must be entirely fabricated by the competitors. Magnets of any type are not permitted.
  - c. The device must be entirely passive, no batteries, AC power or other energy sources are permitted for amplification
4. **THE COMPETITION:**
  - a. **Part 1: Device Testing**
    - i. The event supervisor will set up the transmitter and receiver units on surfaces that are of equal height that is at least 50 cm above the floor.
    - ii. Prior to testing any student antenna, the event supervisor will test their provided 3.1 cm monopole antenna at a distance of 4.5 m to determine the threshold dBm reading.
    - iii. During the event teams must be called up one at a time to test their antenna.
    - iv. Teams must have up to three opportunities to test their antenna for connection with the receiver.
    - v. Connection of the antenna with the receiver is defined by an average (over 10 sec) measured dBm reading equal to or higher than the threshold dBm reading obtained by the supervisor's 3.1 cm monopole antenna.
    - vi. Teams must select their first starting distance (measured to the nearest 25.0 cm) at which to place the transmitter/antenna device.
    - vii. Teams will then be given one minute to attach their antenna to the transmitting device, adjust the antenna, step away and indicate that their device is ready for testing. The event supervisor will then

measure the dBm reading using a receiver and will inform the students after the 10 second period if connection was achieved.

- viii. If connection was achieved, students may elect to move the receiver to a farther distance for their next connection attempt. The transmitting setup must not be moved.
- ix. If connection was not achieved, students may elect to move their transmitting setup to a closer distance for their next connection attempt but must not be allowed to move to a farther distance for their next connection attempt.
- x. Event supervisors must record the distance of all connection attempts for all teams and whether the connection was successful or not (whether the average dBm reading surpassed -50 dBm over the 10 second period)
- xi. Event supervisors are encouraged to share the specifications of the testing location with all teams at least two weeks in advance of a tournament, including the maximum possible transmitting distance.

#### b. Part 2: Written Test

- i. Students must take a test on concepts related to antennas and electromagnetic wave propagation while their antenna is not being tested.
- ii. The test must be worth 50 points
- iii. The competition must consist of at least one task/question from each of the following areas:
  - (1) The Electromagnetic Spectrum, radio waves, and EM wave propagation
  - (2) Relating velocity, wavelength, and frequency for waves, with emphasis on radio waves
  - (3) Common antenna designs, compare/contrast different types of antennas
  - (4) Gain patterns, the radar equation, impedance, bandwidth, noise, and information

#### 5. **SCORING:** High score wins.

- a. The antenna score must be calculated as follows:
  - i. The team that has the farthest distance for a successful connection will receive 50 points.
  - ii. All other teams will be scored by  $\text{Antenna Score} = (d_{\text{team}}/d_{\text{max}})*50$
  - iii. A team's Antenna Score must be calculated from a team's highest scoring connection attempt.
- b. Teams with no successful connection attempts must be awarded an antenna score of 0 points.
- c. Teams who violate any construction parameters must be awarded an antenna score of -10 points, regardless of the number of violations, and must not be allowed to test their device until it is brought into proper specs.
- d. Teams whose antenna cannot be tested, is not impounded, or is deemed unsafe by the event supervisor must be awarded an antenna score of -20 points.
- e. Total Score = Test Score (max of 50 points) + Antenna Score (Max of 50 pts)
- f. Ties will be broken in the following order: (1) Higher Antenna Score, (2) Number of Successful Connections, (3) Test Score, (4) Specific Test Questions

**Recommended Resources:** All reference and training resources are available on the Official Science Olympiad Store and Website at <http://www.soinc.org>