

Radio Lab

1. **DESCRIPTION:** Teams must design an antenna that is able to most efficiently receive radio waves and answer questions related to the EM spectrum.

A TEAM OF UP TO: 2 **EYE PROTECTION:** None **IMPOUND:** Yes **APPROX. TIME:** 50 Minutes

2. **EVENT PARAMETERS:**

- a. Competitors may bring any materials, tools and type of calculators for use during any part of the competition.
- b. All reference materials to be used during all parts of the competition must be secured in a 3-ring binder, must be 3-hole punched and inserted in the binder so that regardless of orientation nothing can fall out.
- c. Event Supervisors provide the radio wave source, transmit antenna, and signal strength receiver circuit

3. **CONSTRUCTION:**

- a. Devices must fit within a 75 x 75 x 75 cm cube in any orientation of the team's choosing.
- b. Devices may be made out of any materials.
- c. Devices must have a 50 Ohm BNC female connection to attach to the signal strength receiver circuit.
- d. Devices must be designed to receive signals with a frequency of 100 MHz and in the range of 200 MHz to 300 MHz. At regionals the gap between possible frequencies is 50 MHz, at state it is 25 MHz, at nationals it is 10 MHz.
- e. Devices may be modified on-site.

4. **THE COMPETITION:** The competition consists of two parts that include experimental tasks and questions related to the EM spectrum.

- a. At the event supervisor's discretion, spectators are permitted to watch Part 2 of the competition, but must not interact with teams participating in Part 1.
- b. Part 1: Written test on the EM spectrum
 - i. All answers are to be provided in SI units with proper significant figures.
 - ii. The test must be worth 50 points.
 - iii. Teams must be given at least 30 minutes to complete the test.
 - iv. The test may include the following topics:
 1. Maxwell's equations
 2. Wave propagation
 3. Electromagnetic Properties of Materials
 4. Common Antenna Designs
 5. The concepts of gain, bandwidth, signal to noise ratio
 6. The radar equation
 7. Transmission Lines/Impedance
 8. Filters
 9. Mixers
 10. Amplifiers
 11. Basic concepts from communication
- c. Part 2: Antenna testing
 - i. The event supervisor must provide a $\frac{1}{2}$ wave dipole antenna and a circuit that generates a continuous wave signal in the 0 to 4 dbm power range.
 - i. After all devices are impounded, event supervisors must announce the second frequency (within the range of 200 MHz to 300 MHz) that will be tested.
 - ii. The event supervisor must also provide a portable signal strength meter (i.e. oscilloscope, power meter or event specific testing equipment) with a male 50 ohm BNC connection on at least a 1 m flexible wire. See the event page at ??? for suggested testing configurations.
 - iii. Teams must have 10 minutes to complete the following:
 1. Connect their antenna to the signal strength circuit

2. Back away from the transmit antenna which is actively broadcasting at the first frequency while holding their device in any orientations of their choosing until the signal strength circuit drops below a set threshold.
 3. Allow the supervisor to mark the location of the maximum distance of detected signal.
 4. Modify their device if the team desires.
 5. Repeat the above process for the second frequency.
- iv. Event supervisors must measure the-maximum distance of detected signal for both frequencies to the nearest cm. Time taken for measurement must not count against the 10 minutes allowed to each team to compete.
 - v. The teams' total distance score for part 2 is the sum of the 2 distances.

5. **SCORING:**

- a. The highest total points wins. Points are awarded for correct answers on part 1 and distance from the transmit antenna on part 2.
- b. Points are distributed in the following manner:
 - i. Part 1: Written test max of 50 points
 - ii. Part 2: Antenna testing (total distance score / largest total distance score of all teams) x 50 points
- c. Scoring example: **NEED TO FILL IN**
- d. Teams that violate a rule will be tiered behind all teams that do not violate any rules.
- e. Ties are broken using a designated task(s) or question(s). The event supervisor must identify the tiebreaker question(s) or task(s) on the answer form provided to the students at the beginning of the competition period.

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