

## WiFi Lab (October 2016 Version)

1. **DESCRIPTION:** Teams may construct an antenna prior to the tournament that is designed to transmit the maximum power at 2.4 GHz to a receiver a distance away. Teams 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:**

- a. All reference materials to be used during all parts of the competition must be initially secured in a 3-ring binder so that regardless of orientation none can fall out. Materials such as pencils, pens, protractors, rulers, any type of calculators, and any other similar tools may also be used during the event.
- b. The antenna must be placed in a box (antenna and box must be labeled with the team name and competition #) and must be impounded. Tools and supplies do not need to be impounded.
- c. The supervisor must provide the testing materials listed below (Example setups are provided on the event page on [www.soinc.org](http://www.soinc.org)), which must be the same for all teams:
  - i. A transmitter that supplies a 2 mW, 2.4 GHz, 802.15.4 encoded signal (e.g. a standard WiFi access point / router with external antennas)
  - ii. A 30.0 cm x 30.0 cm x 0.05 cm metal sheet attached to a tripod with an SMA-F connector in the middle
  - iii. SMA Female and Male adapters and an antenna cable to connect the transmitter to the metal sheet
  - iv. A receiver that can display the received power in dBm with at least -80 dBm sensitivity (wifi-enabled laptop with inSSIDer v2.0 and the Simple Network Analyzer software recommended)
  - v. A 3.1 cm monopole antenna to set the threshold dBm value
- d. Tournament personnel are encouraged to provide a long space for antenna testing and share room specifications with all competitors at least two weeks before competition.
- e. The event supervisor must set up the transmitter and receiver on surfaces that are of equal height that are at least 50.0 cm above the floor. Once positioned, the transmitter and receiver setup must stay the same for all teams.
- f. Prior to the start of competition, the event supervisor must test their provided 3.1 cm monopole antenna at a distance of 4.5 m to determine the threshold dBm reading.



3. **CONSTRUCTION:**

- a. Each team may bring one pre-constructed antenna.
- b. The antenna must fit within a 10.0 cm x 10.0 cm x 10.0 cm cube during all parts of the competition and cannot be manually supported during testing (i.e. it must be free-standing).
- c. The antenna must include an SMA-M connector that can be connected to the SMA-F connector on the metal sheet.
- d. The antenna may be constructed of and contain any materials except for commercial antenna parts or magnets.
- e. The antenna must be entirely passive; no batteries, AC power or other energy sources are permitted.
- f. Competitors must be able to answer questions regarding the design, construction, and operation of the antenna per the Building Policy found on [www.soinc.org](http://www.soinc.org).

4. **THE COMPETITION:**

Part I: Device Testing

- a. Event supervisors must check the antenna specifications during impound or right before a team's antenna testing period begins. Teams must be notified as soon as possible if an antenna does not meet specifications. Event supervisors may prohibit antennas from being tested if they will damage the testing setup (e.g. due to excessive weight/torque, residue on the metal sheet, etc.)

- b. Teams must have a total of 5 minutes to adjust and repair their antenna, and make 3 connection attempts. Event supervisors must give teams a warning at 4 minutes.
- c. Teams may modify the antenna during the impound period or their Part I testing periods, if time is available. This may be to bring the antenna into compliance with the event specifications. Antennas not meeting construction specifications at the beginning of a 10 second measurement period must be judged as failing the connection attempt. Modifications are not allowed during the 10 second measurement periods.
- d. Once the 5 minutes testing period begins, teams may select a starting distance (measured to the nearest 25.0 cm) at which to have the event supervisor place the receiver unit.
- e. Prior to each connection attempt, teams may connect, disconnect, modify or adjust the antenna as well as the position of the antenna and metal sheet relative to the tripod. Teams may not alter the tripod location.
- f. Once a team is ready for testing, they must step at least 5 feet away from the antenna, and notify the event supervisor.
- g. The event supervisor must then measure the average dBm reading over a 10 second period using the receiver unit.
- h. Connection with the receiver is defined by an average (over 10 seconds) measured dBm reading equal to or higher than the threshold dBm reading obtained by the supervisor's 3.1 cm monopole antenna.
- i. If connection was achieved, the team may elect to move the receiver to a farther distance for their next attempt.
- j. If connection was not achieved, students may elect to move the receiver to a closer distance for their next attempt but must not be allowed to move to a farther distance for their next attempt.
- k. Event supervisors must record the distance of all attempts and whether the connection was successful or not.
- l. Teams that achieve connection at the longest possible distance (as determined by the competition venue) must have their average dBm reading recorded as a tiebreaker (lower dBm wins tiebreaker).
- m. Teams filing an appeal regarding Part I must leave their antenna in the competition area.

#### Part II: Written Test

- n. Teams must be given a minimum of 20 minutes to complete a written test.
  - o. Questions may be multiple choice, true-false, completion, or calculation problems.
  - p. Unless otherwise requested, answers must be provided in metric units with appropriate significant figures.
  - q. The test must consist of at least 5 questions from each of the following areas:
    - i. The Electromagnetic Spectrum, radio waves, and EM wave propagation
    - ii. Relating velocity, wavelength, and frequency for waves, with emphasis on radio waves
    - iii. Common antenna designs, compare/contrast different types of antennas
    - iv. Gain patterns, the radar equation, impedance, bandwidth, noise, and information
5. **SCORING:** A scoring rubric is available on the event page on [www.soinc.org](http://www.soinc.org)
- a. The Antenna Score (AS) =  
 (greatest successful connection distance / greatest successful connection distance of all teams) x 50 points
  - b. The connection distance must be multiplied by 0.7 when calculating the Antenna Score if any construction violation(s) are corrected during Part I or if the team misses impound.
  - c. AS must be zero if a team has no successful connection attempts, is disqualified for unsafe operation, or fails to bring an antenna. Teams must still be allowed to compete in Part II.
  - d. The Test Score (TS) = (Part II score / highest Part II score of all teams) x 50 points
  - e. Final Score = TS + AS. High score wins.
  - f. Ties must be broken in the following order: (1) Higher Antenna Score, (2) Lower dBm Reading at Max Distance, (3) Number of Successful Connections, (4) Test Score

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