WIFI LAB

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Teams must construct an antenna device prior to the tournament that is designed to transmit a signal at 2.4 GHz and complete a written test on the principles of electromagnetic wave propagation.

   A TEAM OF UP TO: 2 **IMPOUND:** Yes **APPROX. TIME:** 50 minutes

2. **EVENT PARAMETERS:**
   a. Each team may bring one three-ring binder of any size containing information in any form and from any source, attached using the available rings. Sheet protectors, lamination, tabs and labels are permitted. Participants may remove information or pages for their use during any part of the event.
   b. Each team may also bring tools, supplies, writing utensils, and two stand-alone calculators of any type for use during any part of the event. These items need not be impounded.
   c. Each team must impound their device, a device diagram, and copies of graphs and/or tables for scoring. Bonus points are given for devices impounded in a labeled box.
   d. The event supervisor will provide the testing materials listed in the COMPETITION AREA section.
   e. Participants must be able to answer questions regarding the design, construction, and operation of the device per the Building Policy found on www.soinc.org.

3. **CONSTRUCTION PARAMETERS:**
   a. Each team may bring one pre-constructed antenna device.
   b. The device must fit within a 15.0 cm x 15.0 cm x 15.0 cm cube during all parts of the competition and must be supported solely by the backplane and the SMA-Female connector mounted in the backplane.
   c. The device must include an SMA-Male connector that can be connected to the backplane connector.
   d. The device may be constructed of any materials except for commercial antenna parts or magnets.
   e. The device must be entirely passive; no batteries, AC power or other energy sources are permitted.
   f. The device must be designed and operated in such a way to not damage or alter the backplane or SMA-F connector (e.g. due to excessive weight/torque, residue on the metal sheet, etc.). Devices are recommended to weigh less than 300 g.
   g. Prior to competition, teams must calibrate devices by preparing graphs/tables showing the relationship between power and distance for various device or testing setup configurations. A labeled device diagram should be included.
      i. Any number of graphs and/or data tables may be submitted but the team must indicate up to four to be used for the Chart Score, otherwise the first four provided are scored.
      ii. Graphs and/or tables may be computer generated or drawn by hand on graph paper. Each data series counts as a separate graph. A template is available at www.soinc.org.
      iii. Teams are encouraged to have a duplicate set to use, as those submitted may not be returned

4. **DESIGN LOG:**
   a. **Teams must submit a Design Log along with their device. The log must include the following:**
      i. **Materials used to construct the device**
      ii. **A labeled diagram or picture that identifies and describes the parts**
      iii. **Team name, team number, and appropriate metric units for all numerical values**
   b. **If a 3-D printer, laser cutter, CNC machine or similar device was used as a tool to build the team's device, or any component thereof, the following information must also be supplied in the log.**
      i. **Information about the tool hardware, software, materials, and supplies used**
      ii. **Details of the source of any digital files (e.g.; CAD, STL, OBJ) utilized by the tool including but not limited to when and where the file was obtained, including the web address if downloaded from the internet**
      iii. **Descriptions of how the team constructed the final device from the tool created components**
   c. **All submitted logs will be returned to teams.**

5. **THE COMPETITION:**

   Part I: Written Test
   a. Teams will be given a minimum of 20 minutes to complete a written test consisting of multiple choice, true-false, completion, or calculation questions/problems.
   b. Unless otherwise requested, answers must be in metric units with appropriate significant figures.

c. The test will consist of at least five 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. **STATE AND NATIONAL ONLY - Mathematical questions involving common antenna designs**
   v. **STATE AND NATIONAL ONLY - Gain patterns, the wave equation, impedance, bandwidth, noise, and information**

Part II: Device Testing

a. Teams have a total of 5 minutes to adjust and repair their device, and make 3 connection attempts. Event Supervisors will give teams a warning at 4 minutes. Devices that do not meet the construction specs will not be allowed to be tested until brought into spec.
b. Once the 5 minute testing period begins, teams may select a starting distance (at 50.0 cm intervals) at which to have the Event Supervisor place the receiver unit.
c. Prior to each connection attempt, teams may connect, disconnect, modify or adjust their antenna device **on the backplane. Teams may not move the transmitting device, which is defined as the backplane, tripod, and wires and connections to the router.** During the process, teams may ask the supervisor **to confirm if the antenna has established a connection** with the transmitter. The supervisor must provide only a yes or no response. The team may not ask the supervisor again during the attempt after receiving a yes response.
d. Once a team is ready for testing, they must step at least 5 feet away from the device, and notify the Event Supervisor.
e. The Event Supervisor will then measure the average dBm reading over a 10 second period using the receiver unit. Modifications are not allowed during the measurement period.
f. 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.
g. If connection was achieved, the team may elect to move the receiver to a farther distance for their next attempt. If connection was not achieved, they 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.
h. Event Supervisors must record the distance of all attempts and whether the connection was successful.
i. Teams that achieve connection at the longest possible distance (as determined by the competition venue) must have their average dBm reading recorded as a bonus.
j. The Supervisor will review with the team the Part II data recorded on their scoresheet.
k. Teams filing an appeal regarding Part II must leave their device in the competition area.

6. **<u>COMPETITION AREA</u>:**
   a. Example setups are provided on the event page at www.soinc.org
   b. The Event Supervisor will provide the testing materials listed below, which will 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 ~0.5 cm backplane constructed of a non-conducting, low-dielectric material such as MDF, wood, or particle board (the backplane) attached to a tripod with an SMA-Female connector in the middle**
      iii. Adapters and an antenna cable to connect the transmitter **to the backplane**
      iv. **A receiver that can display the received power in dBm with at least -80 dBm sensitivity (WiFiInfoView https://www.nirsoft.net/utils/wifi_information_view.html is recommended for PCs and the Wi-Fi Scanner Tool that is native in Mac OS X.)**
      v. A 3.1 cm monopole antenna for setting the connection threshold dBm value
   c. Tournament personnel are encouraged to provide a long space for device testing and share room specifications with all participants at least two weeks before the competition.
   d. The Event Supervisor will set up the transmitter and receiver on surfaces that are of equal height and at least 50.0 cm above the floor. Once positioned, the setup must stay the same for all teams.
   e. Prior to the start of competition, the Event Supervisor will test their provided 3.1 cm monopole antenna at a distance of 3.0 m to determine the connection threshold dBm reading.

7. **SCORING:**
   a. Final Score (FS) = ES + AS + CS + IB + MB. The maximum possible FS is 100 points. A scoring spreadsheet is available at www.soinc.org.
   b. Exam Score (ES) = (Part I score / highest Part I score for all teams) x 45 points
   c. Antenna Score (AS) = (greatest successful distance / greatest successful distance for all teams) x 38 points
   d. Chart Score (CS) - One of the submitted graphs/tables, selected by the Event Supervisor, is scored using i., ii., and iii., described below for a maximum of 6 points. Four (4) additional CS points are available via items iv. and v. Partial credit may be given.
      i. 2 points for including data spanning at least 5m distance
      ii. 2 points for including at least 10 data points in each data series
      iii. 2 points for proper labeling (e.g. title, team name, units)
      iv. 0.5 points for each distinct graph or table turned in (up to 2 points total). **Different test runs with the same variables measured are considered distinct graphs or tables.**
      v. 2 points for including a labeled device diagram
   e. Impound Bonus (IB) = 3 points if device impounded in a box labeled with team name & number
   f. Max Bonus (MB) = If multiple teams achieve connection at the maximum distance, the team with the highest dBm reading at the maximum distance will receive a bonus of four points.
   g. AS must be zero if a team has no successful connection attempts, is disqualified for unsafe operation, or fails to bring a device. Such teams will be allowed to compete in Part I.
   h. If any CONSTRUCTION violation(s) are corrected during the competition block, or if the team misses impound, their connection distance will be multiplied by 0.7 when calculating AS..
   i. A team violating any COMPETITION rules during a successful attempt will have their connection distance for that attempt multiplied by 0.9 when calculating AS.
   j. Tie breakers: 1st - Best AS; 2nd - Best dBm at max distance; 3rd – # successful connections; 4th - specific test questions

Recommended Resources: The Science Olympiad Store (store.soinc.org) carries a variety of resources to purchase for this event; other resources are on the Event Pages at soinc.org