

WiFi Lab Transmitter Construction & Setup Guide

For Event Supervisors, Coaches, and Competitors

Version 6.0, October 2017

This document is intended to be used by Science Olympiad teams and event supervisors to assist them in building a WiFi Lab Transmitter that will meet all specifications in the event rules for use at a Science Olympiad tournament or to allow competitors to calibrate their devices in preparation for tournaments. An inexpensive and precise transmitter can be built using relatively common supplies with very little radio or antenna construction experience needed.

Transmitter Specifications

According to rule 5.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 ~ 30.0 cm x ~ 30.0 cm x ~ 0.05 cm metal sheet. Supervisors must also provide a linked receiver unit that can display the received power in dBm with at least -80 dBm sensitivity.

Note: There are 2 types of incompatible connectors commonly available on WiFi equipment: SMA and RP-SMA (or RSMA). As shown in the picture at right, the RP (Reverse-polarity) SMA has a center pin on the female/jack connector (which has an external thread), while the SMA has the center pin on the male/plug (which has an internal thread). Many WiFi router manufacturers use the RP-SMA standard, but routers with the SMA standard may be used with an appropriate adapter cable.



Supplies Needed

- Steel sheet, thickness ~ 0.5 mm, ~ 30 cm x ~ 30 cm (e.g. Amazon ASIN: B00ICS712W, \$12)
- Standard tripod, height ≥ 50 cm (e.g. Amazon ASIN: B00XI87KV8, \$13)
- 2 $\frac{1}{4}$ -20 x ~ 2 " bolts and nuts (e.g. Amazon ASIN: B00L1L86KS and B000BPEPNW)
- WiFi router/AP with detachable RP-SMA antenna (e.g. ASUS RT-N12, Amazon ASIN: B00DWFPDNO, \$30)
- Antenna extension cable, RP-SMA male to SMA male (e.g. Amazon ASIN: B06XRQP6MG, \$15)
- SMA female – SMA female bulkhead adapter (e.g. Amazon ASIN: B00CVQ3KJO, \$6)
- Ethernet Cable, RJ-45 connectors (e.g. Amazon ASIN: B003O973OA, \$6)
- 2 Power Extension Cords (e.g. Amazon ASIN: B00OS7ETIA, \$17)
- Laptop computer with WiFi capabilities
- Acrylic WiFi software (PCs), WiFi Scanner software (Macs)
- Rolling table or cart to place laptop on, at same height as transmitter setup
- Paperclip, uncoated, for use as reference monopole antenna
- Tape measure / masking tape to mark distances on floor
- Tools: drill, $\frac{5}{16}$ " drill bit

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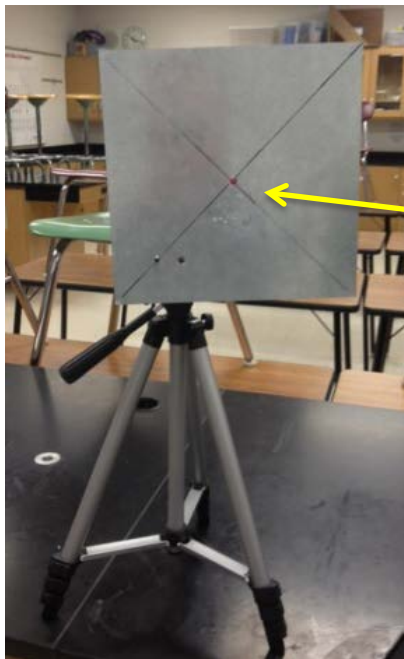
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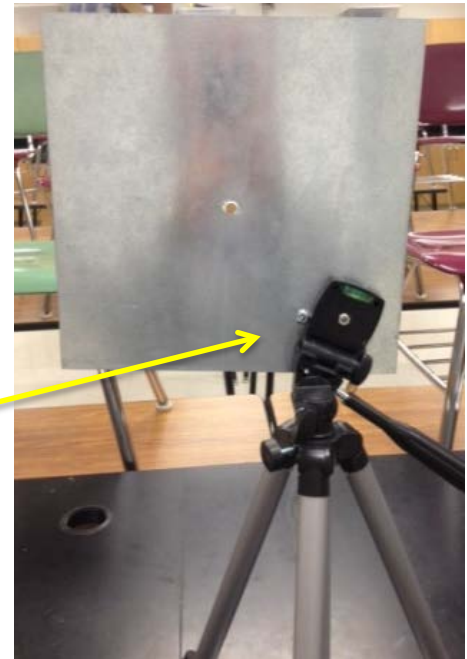
Transmitter Construction

Construction begins with the steel sheet, if the sheet is too large, cut it down to ~30 cm x ~30 cm. Find the center of the sheet and drill a hole with a 5/16" bit through the center of the plate. It is easiest to find the center of the plate by drawing two diagonals connecting opposite corners and finding their intersection point. Insert the SMA-F to SMA-F bulkhead adapter into this hole and secure in place with the included nut.

Near one of the corners, drill 2 holes with the 5/16" bit ~5cm apart. These will be used to secure the sheet to the tripod, which is adjustable, so the exact positioning isn't important. Insert a 1/4-20 bolt through one hole and secure with a nut, then use the other hole to secure the sheet to the removable tripod shoe. The first bolt will help ensure the plate can't rotate about the bolt connected to the shoe.



In the left image, note the hole in the center of grounding plate. The tripod is not extended to its maximum height in either image. In the right image, note the tripod is connected to the grounding plate in the lower corner area.



Unscrew the original antenna in the back of the WiFi router. You will not need this antenna for the transmitter but save it if you want to use the access point for the internet at a later date. Connect the RP-SMA male end of the antenna extension cable to the connector on the back of the router, and take the other cable end (SMA male) and connect to the bulkhead adapter mounted on the steel sheet.

Unbend a paperclip and break off a ~3.1 cm length of the wire. This is the reference monopole antenna. Insert the paperclip into the center hole of the SMA-F bulkhead adapter (on the opposite side of the sheet from the antenna extension cable).

Before testing any antennas, be sure to connect the WiFi router to a local area network or a computer via the ethernet cable to ensure that a signal is transmitted (and of course use the extension cord to plug it in).

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Receiving Unit

The receiving unit is typically a laptop with WIFI capabilities and free software such as Acrylic WiFi (PCs: <https://www.acrylicwifi.com/en/wlan-software/wlan-scanner-acrylic-wifi-free/>) or KisMac (Macs: <http://kismac-ng.org/>)



The screenshot shows the KisMAC 0.3.1 software interface. It displays a table of detected WiFi networks with columns for #, Ch, SSID, BSSID, Enc, Type, Signal, Avg, and Max. The table lists various networks such as 13 11 SwedishFish, 10 1 SSV36, 8 6 dune, 9 2 COWBOYS1001, 7 6 66N64, 5 9 happycat, 20 11 The Castle, 6 6 ShangriLa, 1 1 BH86T, 4 9 UX8EO, 11 11 Negative, 19 1 N9XP5, 12 11 344A2, 0 1 M2O46, 18 11 tom@home, 14 11 RudysNetwork, 3 3 john w, 15 6 linksys, 2 1 7J4X5, 16 1 WC126, and 17 1 FVTV3.

Your wireless transmitter will show up in a table such as shown above. Note the RSSI or Signal columns show the signal strength, which can be monitored over a 10 second period to determine an average.

Use the tape measure and masking tape to mark off distances away from the transmitter steel sheet, starting at 1m (marked every 0.5m for as long as the room allows). Place the laptop on the rolling table or cart at the 3m mark to do the reference monopole antenna testing. Use the second extension cord to plug in the laptop to ensure it remains powered on throughout the event. Adjust the tripod so that the center SMA-F connector is at the same height as the laptop for the duration of the event.

Transmitter Setup – Attach team antenna here



Receiving laptop with WiFi software.