

WiFi Lab Transmitter Construction & Setup Guide

For Competitors, Coaches, and Event Supervisors

Version 7.1, updated October 2021

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.

Transmitter Specifications

According to rule 5.b (see the Rules Clarification posted on 10/21/21 at <https://www.soinc.org/events/rules-clarifications>), event supervisors must supply a transmitter that supplies a 2 mW, 2.4 GHz, 802.11 encoded signal to an SMA-F connector that is mounted through a ~30 cm x ~30 cm backplane that is constructed using a non-conducting material such as MDF, wood, or particle board. The thickness should be relatively low. 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 two types of incompatible connectors commonly available on WiFi equipment: SMA and RP-SMA (also known as RSMA). As shown in the picture on the 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 female standard, but routers with the SMA standard may be used with an appropriate adapter cable.



Supplies Needed

- Nonconducting material sheet, ~30 cm x 30 cm
- Standard tripod, height \geq 50 cm (e.g. Amazon ASIN: B00XI87KV8, \$18)
- Two ¼-20 x ~2" bolts and nuts
- WiFi router/AP with detachable RP-SMA antenna (e.g. ASUS RT-N12, Amazon ASIN: B00DWFPDNO, \$30)
- SMA female - SMA female bulkhead adapter (e.g. Amazon ASIN: B07BXZ2NDV, \$7)
- 2 Power Extension Cords (e.g. Amazon ASIN: B00OS7ETIA, \$19)
- Antenna Extension Cable, RP-SMA male to SMA male (if this cannot be found different adaptors can be used to accomplish the connection of the router to the SMA female connector on the backplane)
- Laptop computer with WiFi capabilities
- WiFIInfoView 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, 5/16" drill bit

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Transmitter Construction

Construction begins with the backplane. Cut a piece of nonconducting material (MDF, wood, plastic) to approximately 30 cm long by 30 cm tall. Find the center of the sheet and drill a hole with a 5/16" bit through the center of the backplane. 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 it in place with the included nut.

Near one of the corners, drill two holes with the 5/16" bit around 5 cm apart. These will be used to secure the backplane to the tripod, which is adjustable, so the exact positioning is not 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 ensure that the backplane can't rotate about the bolt connected to the shoe.



The left image shows the front of the backplane, where competitors' antennas will mount. Note the SMA-F connector in the center.

On the reverse side of the backplane, note the tripod is connected in the lower corner area.

The tripod is not extended to its maximum height in either image.



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 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 transmitter. If you cannot find an RP-SMA male to SMA male connector, you can use any combination of cables and adaptors to connect the antenna to the transmitter.

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Important Note: There are 2 types of connectors commonly used with WiFi equipment: SMA and RP-SMA (or RSMA). Each of these types comes in male and female. In order for two connectors to properly connect they must meet both of these requirements:

- One of them must be male and the other female
- Both must be SMA or both must be RP-SMA. In other words, the SMA and RP-SMA types are incompatible with each other.

The cable in the supplies list above has one RP-SMA male end, which connects to the router (on the left in the picture), and one SMA male end, which connects to the backplane (to the right in the picture).

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 female bulkhead adapter (on the opposite side of the sheet from the antenna extension cable).

It is not necessary to connect the WiFi router to a local area network or computer via an ethernet cable.

Receiving Unit

The receiving unit is typically a laptop with WiFi capabilities and free software such as WiFiInfoView (https://www.nirsoft.net/utils/wifi_information_view.html) for PCs and the Wi-Fi Scanner Tool that is native in Mac OS X.

The screenshot shows the WiFiInfoView application window in Full Details Mode. The window title is "WifInfoView - Full Details Mode". The menu bar includes File, Edit, View, Options, and Help. Below the menu bar is a toolbar with icons for file operations. The main area contains a table with the following columns: SSID, MAC Address, PHY Type, RSSI, and Signal Quality. The table lists several "BSD-Guest-WiFi" networks with various signal strengths and qualities. A large black redaction box covers the MAC Address column for several rows. The status bar at the bottom indicates "83 item(s)" and "NirSoft Freeware. http://www.nirsoft.net".

SSID	MAC Address	PHY Type	RSSI	Signal Quality
BSD-Guest-WiFi	[REDACTED]	802.11n/ac	-79	40
BSD-Guest-WiFi	[REDACTED]	802.11n/ac	-71	65
BSD-Guest-WiFi	[REDACTED]	802.11n/ac	-74	57
BSD-Guest-WiFi	[REDACTED]	802.11n/ac	-66	78
BSD-Guest-WiFi	[REDACTED]	802.11n/ac	-79	40
BSD-Guest-WiFi	[REDACTED]	802.11n/ac	-35	96
BSD-Guest-WiFi	[REDACTED]	802.11n/ac	-79	40
BSD-Guest-WiFi	[REDACTED]	802.11n/ac	-79	40

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Scan							
Network Name	BSSID	Security	Protocol	RSSI	Noise	Channel	Band
belkir [redacted]	[redacted]	WPA/WPA2 Personal	802.11n	-87	0	7	2.4GHz
[redacted]	[redacted]	WPA2 Personal	802.11b/g/n	-90	-95	11	2.4GHz
NETC [redacted]	[redacted]	WPA2 Personal	802.11b/g/n	-85	0	6	2.4GHz
[redacted]	[redacted]	WPA/WPA2 Personal	802.11n	-78	0	1	2.4GHz
[redacted]	[redacted]	WPA2 Personal	802.11b/g/n	-71	-95	4	2.4GHz

Your wireless transmitter will show up in a table like those shown above. Note the RSSI column shows 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, starting at 1 m (marked every 0.5 m for as long as the room allows). Place the laptop on a rolling table or cart at the 3 m mark to do the reference monopole antenna testing. Use the second extension cord to plug in the laptop to ensure that it remains powered throughout the event. Adjust the tripod so that the center of the 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.**