WiFi Lab Transmitter Construction & Setup Guide

For Event Supervisors, Coaches, and Students   Version 5.0, July 2013

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 WiFi Lab and allow students to calibrate a WiFi Lab antenna in preparation for tournaments. This manual can also be used by Event Supervisors to construct a WiFi Lab Transmitter to be used at Science Olympiad tournaments.

Transmitter Specifications

According to rule 1.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 cm x 30 cm x 0.5 mm aluminum sheet. Supervisors must also provide a linked receiver unit that can display the received power in dBm with at least -80 dBm sensitivity. It should be noted that steel or any other uniform metal sheet can be substituted for aluminum as the grounding plate.

An inexpensive and precise transmitter can be built using relatively common supplies with very little radio or antenna construction experience needed. This transmitter construction guide will go provide users with a list of components, including software, that are needed to construct this inexpensive transmitter and can be used by both teams and event supervisors at competition with a high degree of confidence.

Supplies Needed for One WiFi Lab Transmitter

> 1 Steel Sheet with thickness 0.5 mm, at least 30 cm x 30 cm **(Home Depot #474878, $5.98)**

> 1 Standard Tripod with height capabilities of 50 cm and nut and bolt for connection (any size that fits)

> 1 Wireless Router/Access Point with SMA Connector for external antenna (such as D-Link)
> *Ex: DI-524 D-Link AirPlus G DI-524 Wireless Router from Amazon.com (around $8.00)*
> *Be sure that the router uses an SMA connector!*

> 1 SMA Antenna Cable with connectors RP-SMA Male to SMA Male, at least 6 feet desired
> *Ex: StarTech 10 ft. RP-SMA to SMA Wireless Antenna Adapter Cable RPSMASMA10MM ($11.99, newegg.com)*

> 1 SMA Female – SMA Female Adapter
> *Ex: SMA Jack to SMA Jack Coupler (Radio Shack 278-013, $7.49)*

> 1 Network Cable (CAT5 or CAT6 with RJ-45 connectors), at least two feet in length but longer would be better

> 1 Power Cord for Router, with a longer cord allowing more abilities to move setup as needed

> 1 Laptop Computer with WIFI capabilities and copy of InSSIDer Freeware Software Installed

     1 Table or other platform to place Laptop on, at same height as transmitter setup.

Tools Needed for Construction: Power Saw for Cutting Thin Steel Sheet, Ruler/Measuring Tape, Super Glue or Solder for Connecting SMA Cable to Steel Grounding Plate, Cordless Drill or Drill Press

Transmitter Construction

Construction begins with a 0.5 mm sheet of steel, which is available at many hardware/home improvement stores. Steel or aluminum sheets are also available at most Lowes and Home Depot stores as well.

If your grounding plate is too large, cut it down to 30 cm x 30 cm. Find the center of the plate 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. This will be where you will connect the SMA cable from the wireless router.

You are now ready to mount your grounding plate onto the tripod. A tripod is used as a mounting device because of its adjustable height as well as simplicity for travel. Any tripod that can extend to a height of 50 cm will be acceptable for the transmitter, and it is suggested that you talk with your school to see if any old tripods are available. It is also possible to use 2x4 wood or PVC to construct a stand for your transmitter.

To mount the grounding plate to the tripod, you want to make sure that the connection is very stable. The connection need not be in the center of the grounding plate, as you must keep in mind that your cable will be connected in the center. In the example below, note that I used two small bolts to connect the grounding plate to the top of the tripod, then adjusted the tripod to make sure that the grounding plate was perpendicular to the ground.
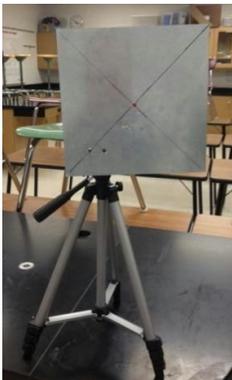
In the left image, note the hole in the center of grounding plate. The tripod is not extended to its maximum height in either image. In the right image, note the tripod is connected to the grounding plate in the lower corner area.

...dy to work on the connection from the wireless router/access point to the grounding plate. You will need a wireless router/access point with an SMA connector on the back. To find what

type of connector your router has, you need to unscrew the antenna in the back of the 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. A D-Link Access Point works very well for this transmitter.

Instead of purchasing a wireless router/access point, you are recommended to first talk to your school's IT department as they may have a spare wireless access point that will work well. This is much less expensive and will work just as well as a new access point. ***Be aware of Linksys-brand wireless router and access points...they use a different style of connector that is not SMA. This can be made to work with an adapter to change the style of connection but it may be difficult.***

Below are pictures of the wireless access point that I used to set up my WiFi Lab Transmitter. I used a D-Link wireless access point I was given by my school's IT director and it is model number DWL-G700AP. It is a considerably older access point but works very well.

Above, the SMA-M (Reverse Polarity) connector ___ on the back of the D-L___ ss Access Point. Right ___ of the Wireless Acces ___ the SMA-M (RP) co___ well as the Networl ___or and the Power C___

Above, the D-Link Wireless Access Point before I have unscrewed the antenna.

After I have unscrewed th___ from the Wireless Access Point, I screw the RP-SMA-M end of the an SMA cable to the conn___ the back of the Access Point, and take the other end of the cable (SMA-M) and connect th___ grounding plate. Finally, since the rules state that the event supervisor-provided trans___st have a female SMA connector on it, I attach a female – female SMA adapter to the SMA-___ the cable on the grounding plate by screwing it into the SMA-M connector. Before testing ___nas, be sure to attach the network cable to a local area network or a computer to ensure that a signal is transmitted. The WiFi Lab Transmitter is now complete and ready to accept a student-built radio lab antenna with an SMA-M connector.
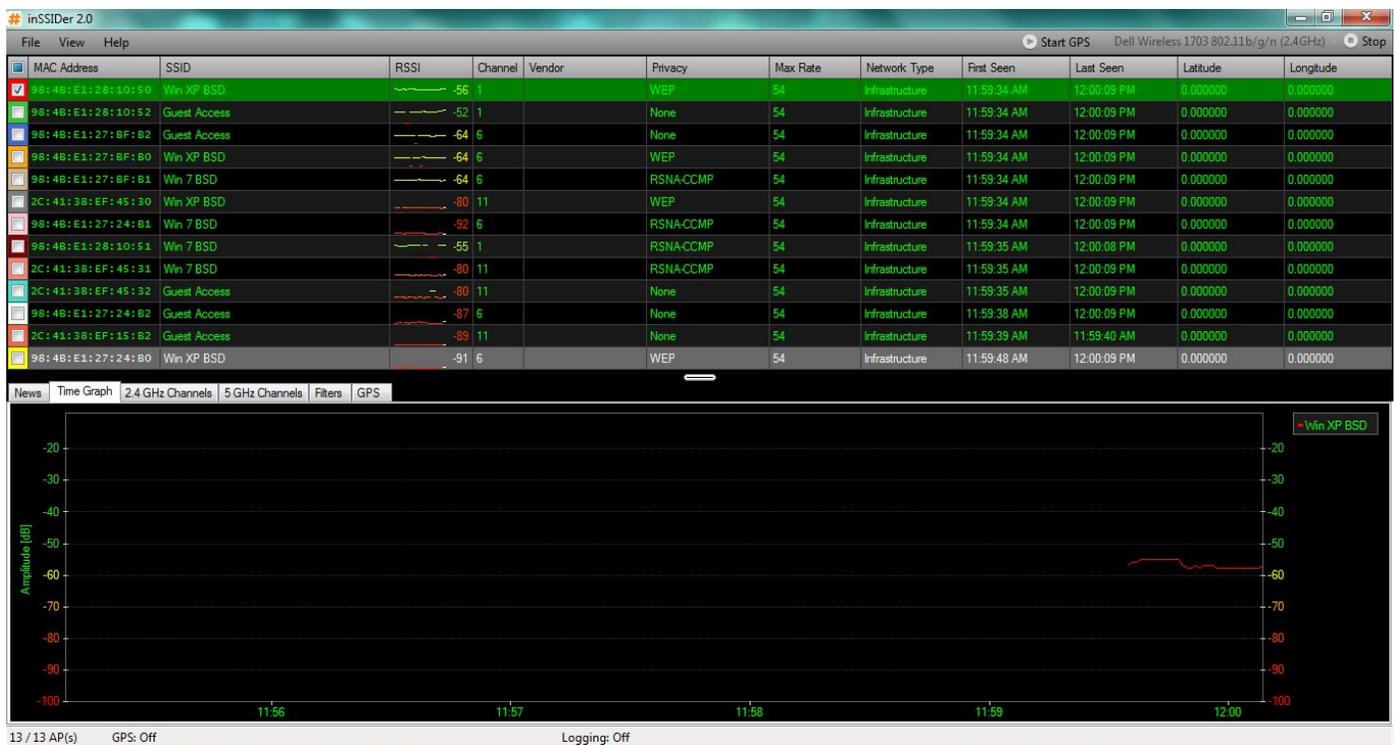
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Receiving Unit

Since the student is building the antenna for the transmitter, the event supervisor will also need to provide a receiving unit. This can be achieved by using a laptop with WIFI capabilities and the freeware inSSIDer version 2.0, which can be downloaded at http://www.metageek.net/products/inssider/

inSSIDer is a free software for both PCs as well as Apple products that detects WIFI signals in the area and presents the signal strength in dBm, with at least -80 dBm resolution, as specified in the rules. Below is a screenshot for inSSIDer version 2.0:


Your wireless transmitter will show up in the table above and you can filter it to only show your signal of interest. Note the RSSI column shows the signal strength, which can be graphed over time in the window on the lower half of the screen.

You will also want to use Sam Grayson's Simple Network Analyzer in conjunction with inSSIDer to log the data and compute an average over a set amount of time. Below is a screenshot:
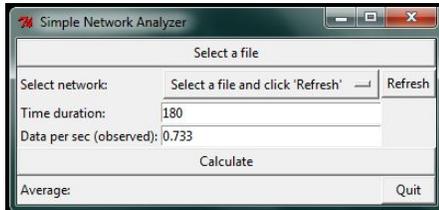
To use the software, first open inSSIDer and, when ready, click file -> start logging. When you are finished with the 10 second period, click file -> end logging. This will save a file to your My Documents (default) folder with the data. Now, you can open the Simple Network Analyzer. First, click the "Select a file" button at the top and select your log file you just created. After clicking the refresh button, select the correct network (probably default) and put "10" in for time duration. Keep the Data per sec (observed) at 0.733 and click calculate; the average RSSI value over the 10 second period will now be displayed.

Final Setup

Below is a picture of the complete final setup. Note that the transmitting setup is located at the same height as the receiver in the laptop, and they are separated by about 5.0 meters of distance. Your students will attach their antenna to the SMA-F connector on the transmitter and you are ready to start collecting data.

Transmitter Setup – Attach Student Antenna Here

Receiving Laptop with inSSIDer software.

You are now ready to have students build and test their WiFi Lab antenna with your Radio Lab Transmitter! Good Luck!