New and Improved ARDF Attenuator for Hidden Transmitter Hunting

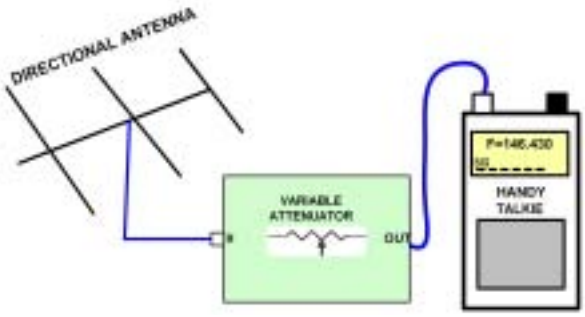
By Rich KR7W

Spring is here and to some hams that means it is time to be thinking about finding hidden transmitters- one of the categories in the "radio sport" part of the amateur radio hobby. You will read elsewhere in this issue of the Bark that the radio club is hosting a big 'Fox Hunt" on May 10 that coincides with (and is part of) CQ Magazine's International Fox Hunt Weekend. The intent of this article is to provide technical information to help the interested radio enthusiast to get started with **A**mateur **R**adio **D**irection **F**inding.

The usual tools for the beginning ARDFer is a directional antenna, an attenuator, and a receiver.

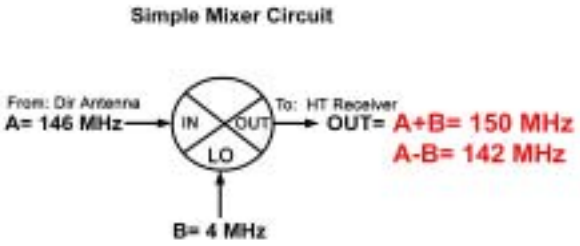
The most popular antenna for newbie's as well as OTs is the WB2HOL 3 element Yagi made from 1 inch tape measure material. (This antenna will be discussed in the May issue of the Bark.)

The attenuator is the device that is needed to lower the hidden transmitter's signal down to a useable level by the receiver. Without the attenuator the receiver's signal strength meter will be saturated to full scale most of the time and the hunter will not be able to get a bearing while rotating the directional antenna.



This article will focus on the variable attenuator needed in the combination of ARDFing equipment. The closer the hunter gets to the Fox (or Bunny= names of the hidden transmitters) the higher the received signal will be. With this in mind… it is important to be able to vary the level of attenuation to keep the receiver's S meter from saturating when rotating the directional antenna. Perhaps you've seen RF attenuators advertised that have many toggle switches to adjust the attenuation by flipping in different steps of attenuation for a total of 95 dB. This type will not work very well for ARDF because there is not enough attenuation at hand when the hunter gets close to the transmitter. Also, it is difficult to flip the switches quickly to get a good S meter reading before the transmitter's signal shuts off for the quiet interval. The best kind of attenuator is one that has a knob that varies the level (for quick adjustments) and has at least 140 dB of attenuation.

Enter the '*Offset Attenuator*'. The offset attenuator uses a common phenomenon in radio theory called mixing or heterodyning (does superhetrodyne ring a bell?) In the offset attenuator there is an input (the signal from the hidden transmitter via the antenna), a local oscillator, and an output (to the receiver). A quick lesson of the theory says: The input signal is combined with the local oscillator (LO) signal in the mixer. The resultant **output** will be the received signal frequency plus (and minus) the LO frequency. Example: A received freq of 146.000 plus / minus the LO freq of 4.000 = 150.000 and 142.000. Tune your handy talkie receiver to one of the *offset* output frequencies and you will be right on to receive the Fox.



The attenuation is adjustable by varying the amount of LO signal to the mixer circuit. The only drawback to this attenuator is the fact that the user can not achieve 0 db of attenuation. The loss of this attenuator is approx 40 to 150 dB. This means that if your Fox signal is too low to be heard through the attenuator then

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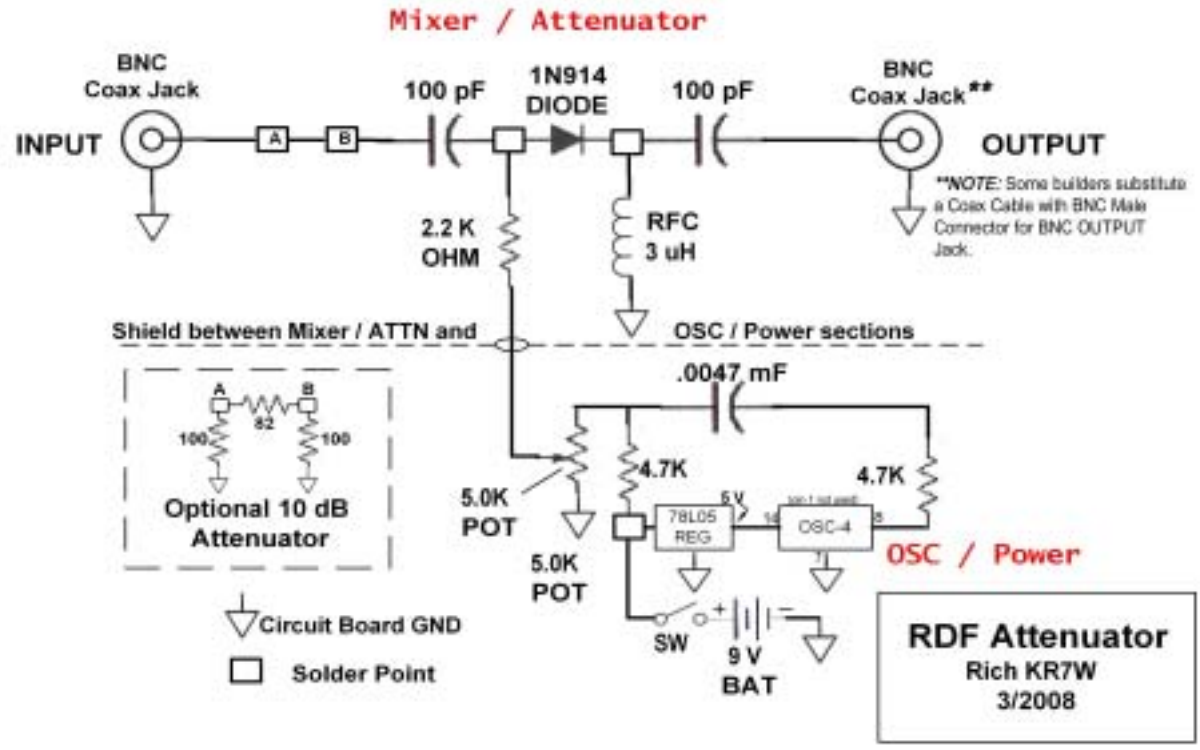
you will have to bypass the attenuator, tune your HT to the actual Fox frequency, and determine the direction of the signal source.

History Lesson: Two years ago myself and Chuck AC7QN held a "build it" class at the radio club where 7 or 8 members built Tape Measure Yagi antennas and a version of the Offset Attenuator found on the web. One member could NOT get theirs to work. After taking it home and troubleshooting it with my O'scope I discovered flaws in the design: The recommended plastic enclosure box did not shield the high output LO signal from the mixer circuit. So the level of the mixer could not be controlled very well at high receive levels. The LO signal was leaking all over the place. (It is just like having RF in your ham shack when you transmit… it can make other equipment work funny.) Also, when the hunter was close to the Fox transmitter… the strong signal would leak through the plastic enclosure and the level of attenuation could not be controlled very well. After much experimenting with different local oscillators and shielding methods… the following is what I have come up with that works very well.

Circuit description: Note the dashed line on the schematic that separates the OSC / Power section (below) and the Mixer / Attenuator section (above). The received signal enters the INPUT jack. Note the squares labeled A and B. This is where an optional 10 dB resistor attenuator solders to. If you do not desire the 10 dB attenuator then leave the jumper between points A and B. The INPUT signal travels through the 100 pF capacitor to the diode (mixer). From the diode the mixed (up) signals pass through the second 100 pF capacitor to the OUTPUT jack to your HT receiver. The RFC (radio frequency choke) provides a DC path for the diode's bias voltage to GND. The output signal is dropped across the RFC, also.

Below the dashed line resides the power supply and OSC section. The 9 volt battery feeds two directions. 1. Through the 4.7 K ohm resistor and 5.0 K ohm potentiometer to GND. The center of the pot feeds part of the 9 volts to the diode mixer circuit to establish bias voltage. 2. Also to the 78L05 regulator unit.



The schematic shows a BNC connector at the OUTPUT. My attenuator has acoax cable with a BNC male plug that plugs directly into my HT receiver. Either method works well.

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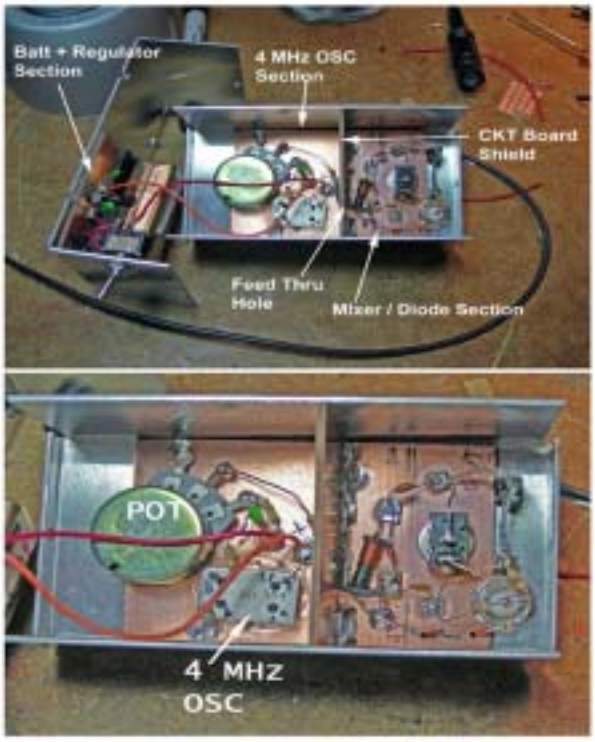
The 78L05 outputs the needed 5.0 volts DC to run the OSC-4 (4.000 MHz oscillator module). The output of the OSC-4 feeds into the 5K pot via the .0047 mF capacitor. The 5K pot also varies the level of the 4.000 MHz oscillator to the diode mixer. Adjusting the pot to lower the OSC-4 level to the mixer equates to more attenuation of the received input signal.

Building the Attenuator: The success to the attenuator working well is to place the parts in an RF proof enclosure. Second to that is to isolate the OSC/Power section from the Mixer/Attenuator section within the enclosure. The components are connected together using the combination of Manhattan and Dead Bug (aka flying lead) circuit construction.

Manhattan construction uses a piece of blank copper printed circuit board (PCB) as a chassis with small (1/4") PCB squares super glued to the chassis. The small PCB squares are tie or connect points. These are shown in the schematic as small squares. The OSC-4 oscillator module is simply super glued to the PCB chassis with its leads aiming up for soldering to (dead bug style). The photos show the PCB cutting and enclosure drilling dimensions and placement of the parts.



This Active Attenuator differs from the schematic. It has a coax cable with male BNC plug instead of the BNC jack on the output side. Also shown here is a switch labeled ATTEN IN/OUT. The schematic for this article leaves this feature out.

Manhattan construction tie points are 1/4 inch pieces of PCB simply super-glued to the PCB chassis. The tie points are tinned with solder and the components are blob soldered down. See www.k8iqy.com for good examples of Manhattan construction.

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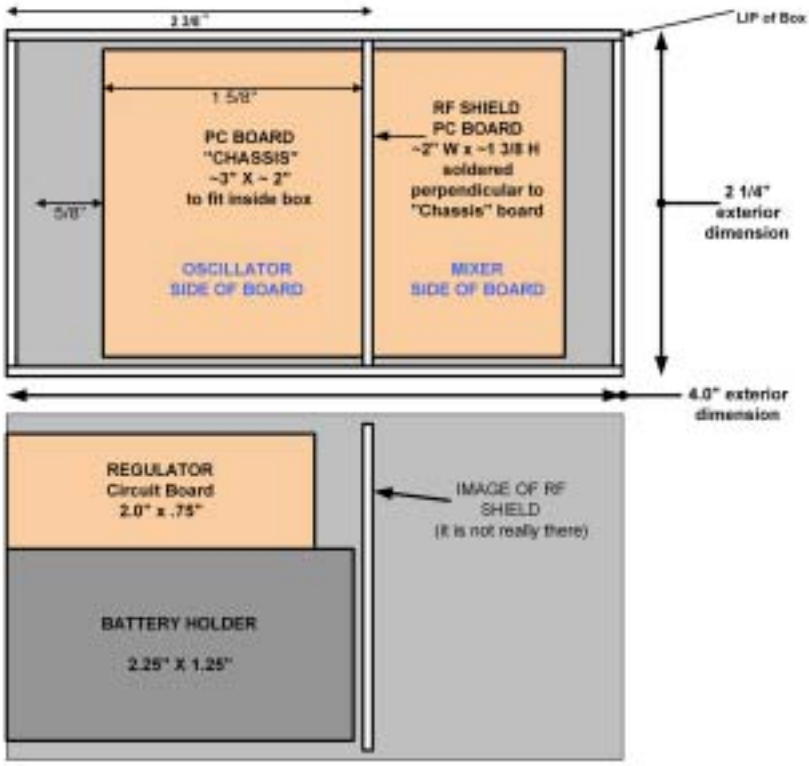
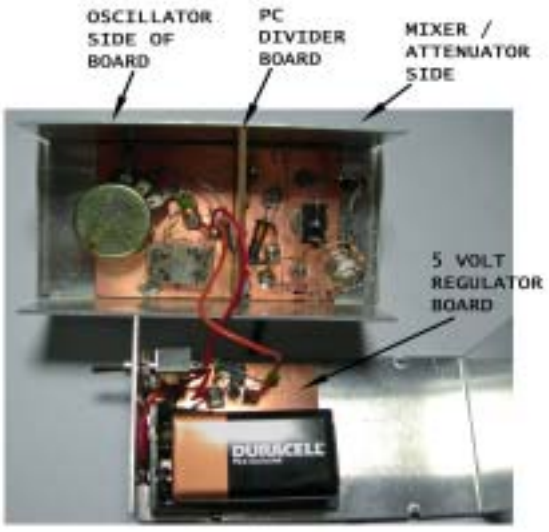


The above diagram shows the layout dimensions for the specified metal enclosure. (see parts list for the specific model of enclosure).

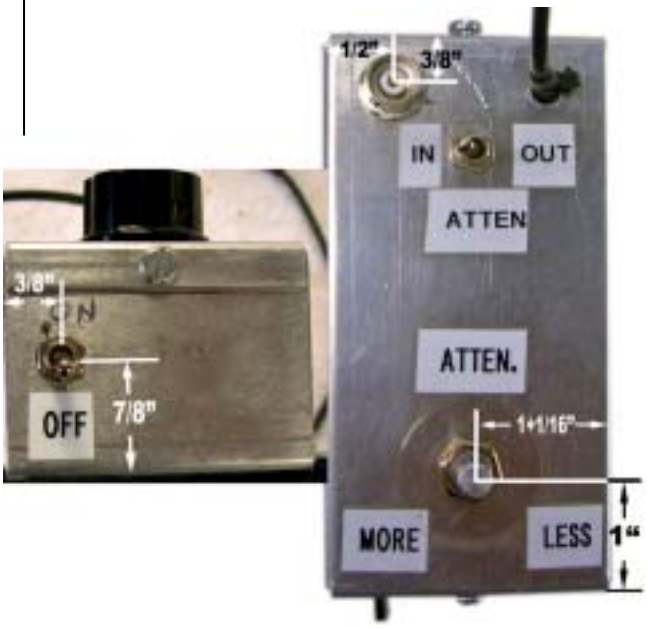
I use a Dremmel tool with diamond wheel to cut the PCB material. Be aware that there will be dust using this method. Also, a hacksaw with the aid of a vice can be used to cut the PCB Material.

Note that some round holes will be drilled in the metal enclosure. I laid out these holes on the enclosure, drilled them, then placed the PCB material in place. I then scribed on the PCB the location of the holes… then lastly drilled the holes in the PCB. Use some scrap PCB to make your Manhattan wiring connection pads.

Obtaining parts: A parts list is provided. I obtained most of the parts from one of my favorite parts suppliers: www.jameco.com. They have everything except the metal enclosure… which came from www.mouser.com. I checked the parts numbers and they are all current.



The more fotos the better… I say.



Above: Hole drilling layout. Note: The ATTEN IN-OUT Switch is not shown in this "how to do it" project. Remember, drill the holes in the enclosure then drill the PCB material.

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List of RDF Active Attenuator Parts	Source
BNC COAX JACKS (QTY=1 or 2)	Jameco.com p/n 355178
BNC Connectors RG-58 Coax (QTY=1 for atten. And 1 for the antenna.	Jameco.com p/n 355240
100 pF ceramic capacitor (QTY=2)	Jameco.com p/n 81525
1N914 Diode (QTY=1)	Jameco.com p/n 655269
RF Choke 3uH (QTY=1)	Jameco.com p/n 372365
5 K Ohm Pot w/ 1/4" shaft… (QTY=1)	Jameco.com p/n 286193 RS?
LM78L05 Voltage Regulator (QTY=1)	Jameco.com p/n 51182
OSC4 4 MHz Oscillator Module (QTY=1)	Jameco.com p/n 27967
9 Volt Battery Holder (QTY=1)	Jameco.com p/n 216427 RS?
9 Volt Battery	Radio Shack or elsewhere
.0047 mF ceramic capacitor (QTY=1)	Jameco.com p/n 138202
2.2K ohm resistor (QTY=1)	Jameco.com p/n 690945 RS?
4.7K ohm resistor (QTY=2)	Jameco.com p/n 691024 RS?
Printed Ckt Bd Material 3x6" (QTY=1)	Jameco.com p/n 169279 RS?
OFF-ON SPST Switch (QTY=1)	Jameco.com p/n 76523 RS?
*** SMA-male to BNC-female (if needed)	Jameco.com p/n 159476
Knob for Pot 1/4" shaft.	Jameco.com p/n 264892 RS?
Metal enclosure 2x4x1.5" LMB00P (QTY=1)	Mouser.com p/n 537-00-P
	RS? Means that you may find this at Radio Shack.

The above chart shows the needed parts. Note that the capacitors are purchased by the 10 quantity and resistors are by the 100 quantity. Even so… they are pretty cheap. I have the capacitors, resistors, and diodes in my lab. I will be happy to sell those parts to you for a buck.

Note that I have included a SMA to BNC adaptor in the list. This is for the folks who have a recently made handy talkie that uses a SMA antenna connection. The attenuator uses a BNC connector on it's output coax toward the HT.

I am willing to assist those who want to build this project. I have tools to crimp BNC connectors, drill holes, cut PCB, etc. If you think you need help… I will be happy to arrange to meet you or a group of folks in the RCT clubhouse museum on Saturdays between now and the big bunny (Fox) hunt on Saturday May 10th. Just let me know what kind of help you need so I can bring the right tools. Also, I am willing to help a group of folks on Sunday or some weekday evening. Let me know and we can arrange something. My phone # is in the RCT roster. Email me at: **rfpatrickXXX@yahoo.com. (rem XXX for delivery)**

Before I forget… *Important note to the group of club members who built the first version of the ARDF attenuators two years ago:* Most of the parts in the old attenuator will fit in the new version. All that is needed is the metal enclosure, some printed circuit board material, and maybe a new battery holder (depending on the style of the old one).

In next months Bark… I will show how to build the Tape Measure Yagi Antenna. Or… if you want to do it now then checkout:
See the club website… www.w7dk.org, scroll down the left column to the pink rabbit. Click

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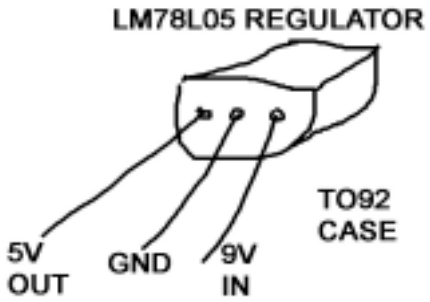
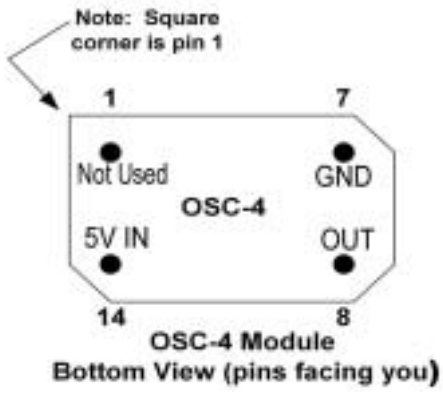
there and you will be transported to the RDF Info Page. Scroll down and find the Tape Measure Yagi link…. OR, See the May 2007 edition of QST Magazine. W1TRC builds the same antenna for 135 MHz, but include the dimensions for 146 MHz. Download the QST article at:
www.kr7w.org/TMY.pdf

Also, next month I will show how to attach your attenuator to the tape measure Yagi.

Be sure to come out to the ARDF Event on Saturday, May 10, at 1300. Bring your kids and/or grandkids. There will be transmitters hidden that are easy to find and more challenging IARU transmitters (5 on the same frequency) that transmit sequentially for one minute ON and 4 minutes OFF. Example: #1 on for one minute, then OFF. Then, #2 on for one minute, then OFF. Then #3 on for one minute… and so on. Joe… bring yourself and the missus out for this gig. If nothing else… it'll be a nice walk in the park.

Regards… Rich KR7W -30-





Additional diagrams for ARDF Attenuator construction...