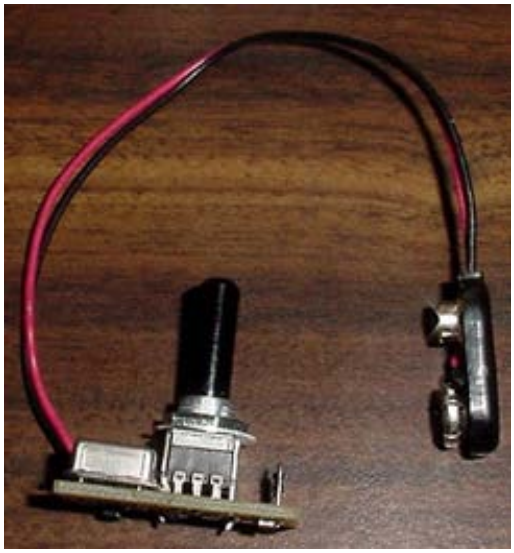
OFFSET ATENUATOR PROJECT
SPRING 2010

GOALS	REQUIREMENTS
• Build a low cost active attenuator to shift receiver frequency up or down	• Small physical size, light weight for handheld use
• Sharpen kit building skills	• Provide adjustable attenuation and low-power consumption
• Utilize the DARC Test Equipment for training and education	• Inexpensive, readily available parts, pre-built SMD circuit
• Gain practical experience in a Fox Hunt	• Simple design
• Have Fun!!	• Easily built and configured

This project started as a collaboration effort to design and build an directional antenna that can be used for fox hunting activities. This document details the building instructions for the attenuator project. Our attenuator was created and designed by Joe Moell, KØOV. The circuit is available from Marvin Johnson, KE6HTS – www.west.net/~marvin. It was originally featured in Homing In, *73 Magazine,* May 1998. More information is available on the HomingIn website: http://homingin.com/.

An RF attenuator is a device that goes between your antenna and receiver to reduce the signal strength to a range that the receiver S-Meter can handle. This calibration of the S-Meter will allow your radio to show signal strength more accurately as you get closer to the hidden transmitter. Without one, you may think you're close to the fox when you're still far away. The amount of attenuation is adjustable so that you can add just a little attenuation when the S-Meter starts to climb, up to a high level of attenuation as you get closer.

The offset attenuator, also called an active attenuator, is used in transmitter hunting to shift the receiver frequency 2MHz or 4MHz up or down from the transmitted frequency. This solves the problem of the main frequency leakage into the receiver that essentially renders a standard attenuator useless when getting close to the transmitter.



The offset attenuator module is assembled on a PC board ¾" x 1¼". The kit consists of the circuit board with all of the surface mount components in place. All other parts necessary to complete the unit (diode, potentiometer, crystal, and 9V battery leads) are provided and will require simple soldering. The surface mount devices include capacitors, resistors, and the voltage regulator. A pre-drilled enclosure is provided along with all necessary antenna connectors and components to complete the project.

DESIGN & CONFIGURATION

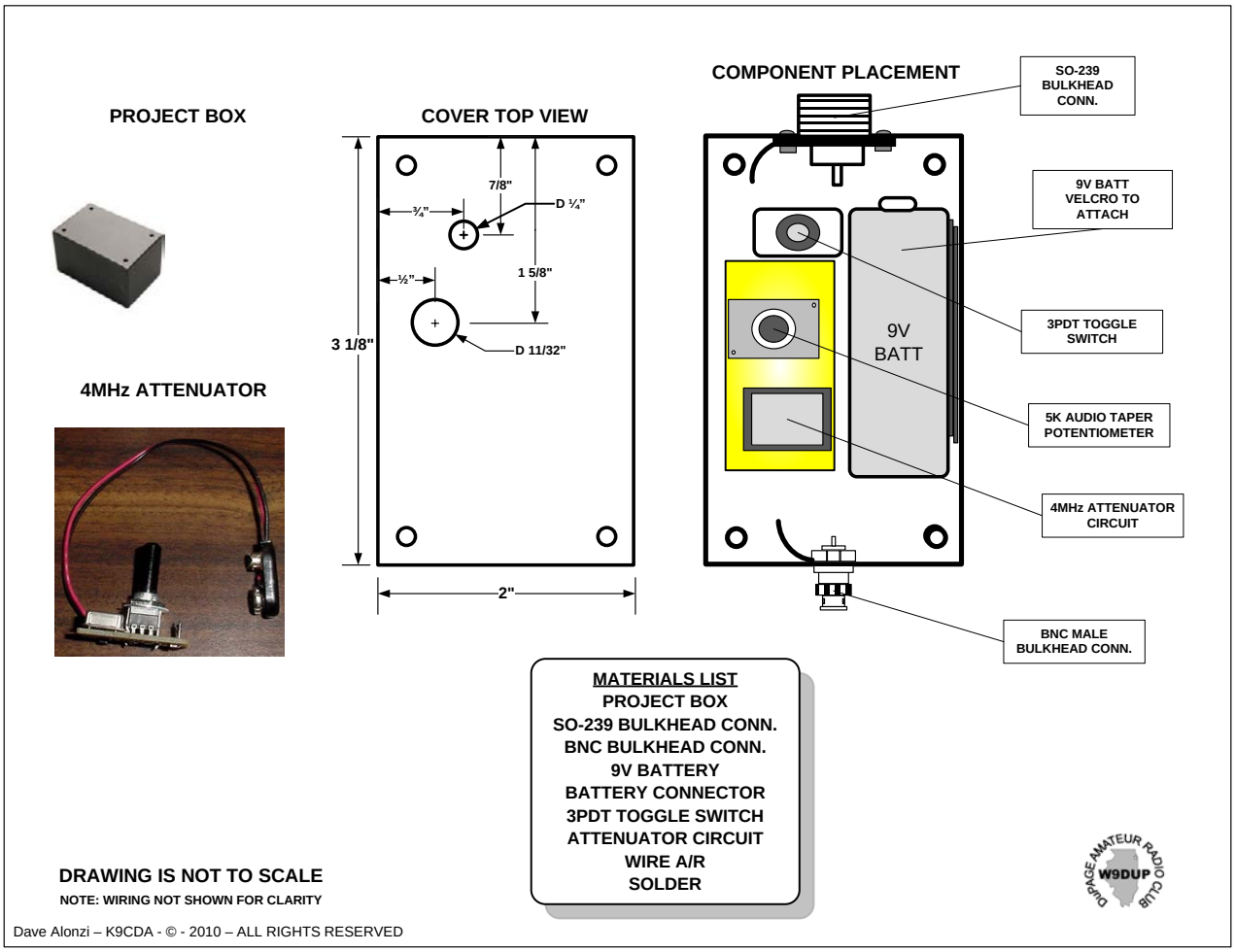


Figure 1 – ATTENUATOR CONFIGURATION

A coaxial cable with BNC Female connector and the proper adaptor for your radio will need to be provided by the builder. A male PL259 plug is required to attach your antenna. The 9V battery is supplied and should last well over 15 hours in normal use.

You will require the following tools to assemble your kit:

SMALL PHILIPS SCREWDRIVER	"NEEDLE NOSE" PLIERS	EXTENSION CORD
SMALL STRAIGHT SCREWDRIVER	SMALL DIAGONAL CUTTERS	CARDBOARD (TO PROTECT TABLETOP)
SOLDER FOR ANTENNA CONNECTORS	25-40 WATT SOLDERING IRON	VOM METER
CIRCUIT BOARD HOLDER (OPTIONAL)	1/2" BOX WRENCH	9/16" OPEN END WRENCH

Construction

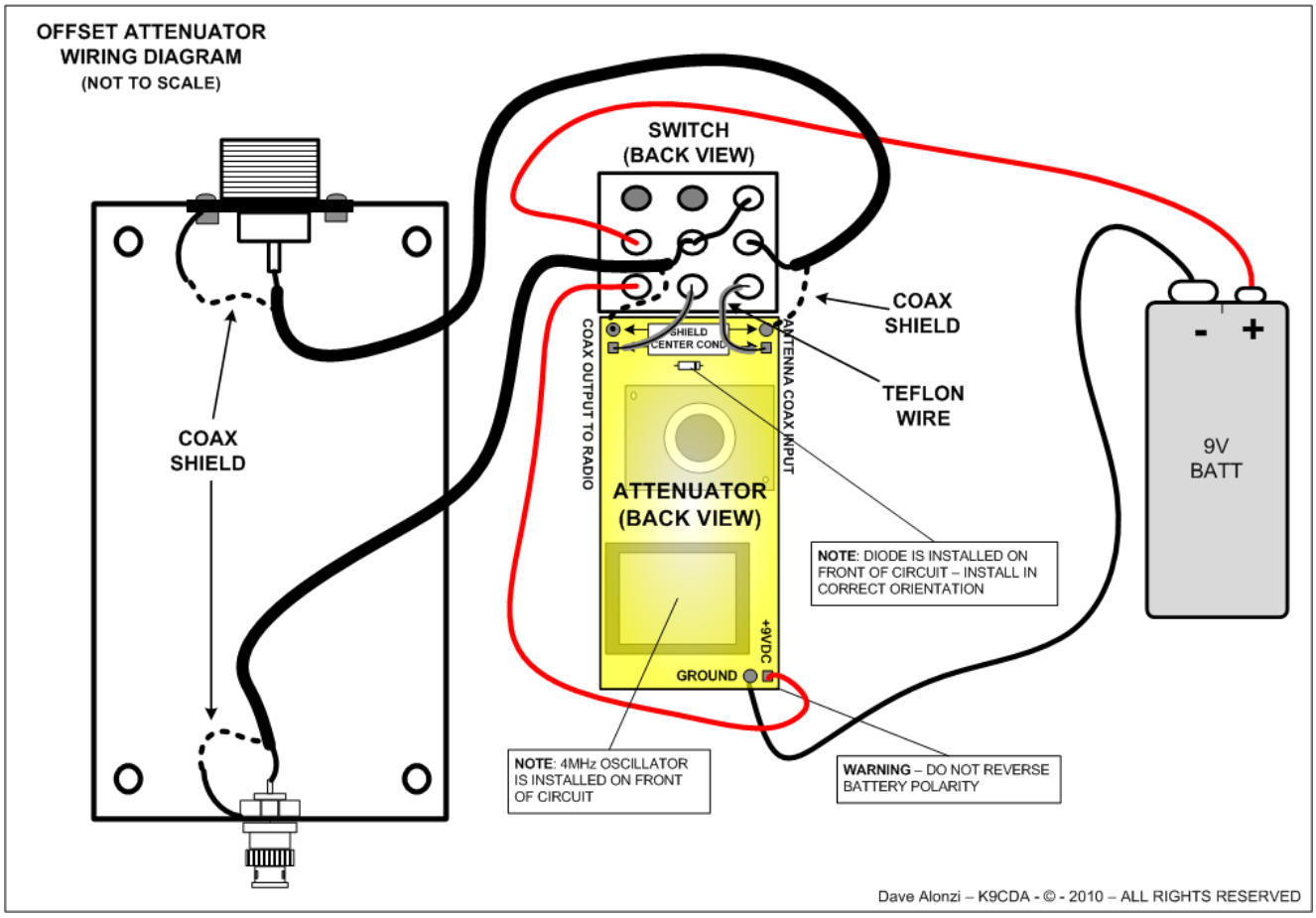


Figure 2 - WIRING DIAGRAM

The construction steps are as follows:

❑	1.	Mount the SO-239 connector to the plastic box. Make sure to orient the solder cup facing up to make it easier to solder later. The SO-239 mounts with two 4-40 screws and nuts. Place a ground lug on the lower screw. Bend the ground lug so it is pointed towards the BNC on the opposite side of the box.
❑	2.	Mount the BNC connector in the other end of the enclosure. Place the ground lug under the mounting nut. Bend the lug so it points toward the SO-239 connector. Tighten the nuts with the ½" box wrench holding the outside with the 9/16" wrench. Do not over tighten the BNC connector.
❑	3.	Orient the box so the SO-239 connector is facing away from you. Keeping the Hook & Loop material together, adhere the **LOOP** side of the Velcro pad to the battery; then attach the it on the right side of the box. Refer to Figure 1 for the parts orientation.
❑	4.	Mount the toggle switch onto the aluminum top plate in the smaller hole. Orient the switch so the two blank contacts face toward the top of the plate. Refer to Figure 1 for proper orientation. Don't over-tighten the switch when you mount it.

❑	5.	Locate and mount the potentiometer on the aluminum plate so the 3 pins face towards the center.
❑	6.	Refer to the instructions supplied with the circuit to identify and install the 1N4148 diode. The diode must be installed correctly paying attention to the polarity. **NOTE**: The diode mounts on the NON-COMPONENT side of the board.
❑	7.	Install the oscillator module on the circuit board. Pin-1 is located on the squared off corner of the module. Mount the module on the non-component side of the board as indicated. Make sure that Pin-1 is oriented in the correct location on the square pad as indicated on the instruction sheet.
❑	8.	Solder the oscillator and diode on the back side of the board using the small diameter solder provided in the package. Do not apply excessive heat or solder to the pins. Make sure you do not bridge any of the connections.
❑	9.	Straighten the mounting tabs on the potentiometer closest to the oscillator module using the needle nose pliers. Press fit the potentiometer to the NON-component side of the circuit board. Make sure that the potentiometer pins do not contact the oscillator module.
❑	10.	Solder the three pins and the mounting tabs to the circuit board. Again, using the small diameter solder; do not apply excessive heat or solder.
❑	11.	In the next several steps you will be connecting the toggle switch to the coaxial cable and to the circuit board. Use caution soldering the switch and wires as the coaxial cable insulation will melt with excessive heat. The cables are prepared and will be installed according to the wiring diagram shown in Figure 2.
❑	12.	Solder a small wire jumper from the center connection to the upper right on the toggle switch, and then connect the center conductor of one of the coaxial cables. The braided wire is soldered to the circuit board as shown.
❑	13.	Solder the second coaxial cable center conductor to the right center switch terminal as shown in Figure 2. The braided section will be soldered to the circuit board pad as shown.
❑	14.	Connect the coaxial cable that is attached to the left side of the board (refer to the instruction sheet) marked COAX OUTPUT TO RADIO to the BNC connector with the center conductor soldered to the center pin on the bulkhead connector. Place a small drop of solder on the connector pin and the ground lug prior to attaching the coaxial cable. Gently solder the center conductor to the pin. Do not use excessive solder.
❑	15.	Connect the coaxial cable that is attached to the right side of the board (refer to the instruction sheet) marked ANTENNA COAX INPUT to the SO-239 connector with the center conductor soldered to the center pin on the bulkhead connector. Place a small drop of solder on the connector pin and the ground lug prior to attaching the coaxial cable.
❑	16.	Solder the TEFLON covered wires to the switch in the lower center, and lower right locations. Attach the other ends to the circuit board as shown in Figure-2.
❑	17.	Before installing the cover, check all connections for cold or loose solder joints. Correct any problems now. Install the pipe clamp on the back of the project box with the screws provided.
❑	18.	If satisfied that all connections are acceptable, install the battery into the box, and connect the battery terminal. Install the circuit board and cover assembly, and lightly screw on the top.
❑	19.	Test the attenuator.

Testing & Tuning

CAUTION:
DO NOT TRANSMIT INTO THE ATTENUATOR AS PERMANENT DAMAGE WILL RESULT!

Your new attenuator is now built and ready for testing and final adjusting.

Using your offset attenuator for foxhunting is easy and efficient, once you get the hang of it. An S-meter on your receiver is a big help in getting Radio Direction Finding (RDF) bearings. Using this attenuator and your small Yagi antenna will help pinpoint a hidden transmitter, or source of interference. You can open the squelch and use the quieting property of FM signals to get a good idea of signal direction.

At first, get bearings on the fox's frequency with the power switch turned on. Start with the dial full clockwise, which is minimum attenuation (about 24dB). Increase the attenuation as necessary by turning the knob counterclockwise. Fully counterclockwise will attenuate the received signal by about 98dB.

Current drain of this unit is 4.9mA, so expected battery life should exceed 100 hours.

Offset attenuator operation may be degraded on frequencies than are an exact multiple of the oscillator, such as 144.0MHz and 148.0MHz. If there is a strong communication or paging transmitter that offsets onto the frequency you are monitoring, you may experience cross-modulation interference. An example would be QRM from NOAA weather radio on 162.55MHz when you are hunting a 146.55MHz signal by listening on 150.55MHz. This effect is worse with odd multiples of the oscillator frequency and oscillators below 4MHz.

Avoid transmitting through this attenuator. Your antenna will emit strong spurious signals and you may burn out diode D1. Set the power output down to the lowest possible level on your hand-held. Fortunately, if you forget and cause a failure, repairs are easy and inexpensive.

Parts List & Schematic

COMPONENT	DESCRIPTION
C1, 2	470 pF 0805 SMT CERAMIC CAP
C3	.0047 µF 0805 SMT CERAMIC CAP
R1, 2	2.2K 1/4 WATT, 0805 SMT
R3	4.7K 1/4 WATT, 0805 SMT
D1	1N4148 SIGNAL DIODE
VR1	5K AUDIO TAPER POTENTIOMETER (6MM SHAFT)
U1	7805 REGULATOR (+5V) SMT
X1	4.0MHz OSCILLATOR, 1/2 SIZE
MISC.	BATTERY CONNECTOR
	PC BOARD
	WIRE, COAXIAL CABLE, SOLDER A/R
	PLASTIC ENCLOSURE