An Offset Attenuator for Radio Direction Finding

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Revised: Wednesday, February 28, 2001

Near the end of a transmitter hunt, when the hunter is within a mile or so of the hidden transmitter, the signal level will often exceed the maximum level that a receiver's signal strength indicator can register. The S-meter is "maxed out" and is useless for indicating changes in signal strength. When this occurs a passive resistor network is often used to knock the signal strength down to a useful level. Using a passive attenuator has two main limitations:

- The maximum signal attenuation is limited to 80 dB or so.
- When a signal needs to be attenuated by 80 dB or more, the signal is often strong enough to enter the receiver through its case, bypassing the attenuator and the direction finding antenna.

An offset attenuator can overcome both of these limitations by

- Providing attenuation in excess of 100 dB.
- Allowing the receiver frequency to be set several megahertz away from the hunt frequency, so that the receiver is not directly affected by the strong signal from the hidden transmitter.

The following offset attenuator design has a few additional features not found in most other offset attenuators:

- A 10-dB resistor network attenuator at the front-end that provides some attenuation on the hunt frequency.
- A clipper circuit helps prevent damage to your receiver when in close proximity to a strong signal source.

How An Offset Attenuator Works

Instead of acting directly on the incoming signal, an offset attenuator works by adjusting the strength of an offset signal (a mixer product frequency). Your receiver therefore needs to be tuned to the offset frequency instead of the frequency of the signal you are hunting. The offset attenuator does not control the strength of the incoming signal, but instead allows extremely wide control over the strength of the offset signal.

An offset attenuator consists of a local oscillator and a mixer. The signal arriving from the direction finding antenna is fed into one input of the mixer. The signal from the local oscillator is fed through a variable attenuator (typically a potentiometer) to the other mixer input. The mixer products are fed to the receiver, which is tuned to one of the product frequencies. Product signal strength is set by adjusting the level of the local oscillator signal reaching the mixer, which is accomplished by adjusting the potentiometer.

Circuit Description

A schematic diagram for an offset attenuator is shown in Figure 1. The oscillator (U2) is a 4-MHz single-chip device, and requires no alignment. A 5-volt power source is provided to U2 by a 9-volt battery regulated by U1, a 5-volt regulator IC.

D1 acts as the mixer in the circuit. Oscillator signal strength at the mixer is set by potentiometer VR1. R4, R5, and R6 provide approximately 10-dB of *passive* attenuation of the incoming signal, and D2-5 clip the signal if it exceeds 1.4V p-p. The diode clipper helps protect your receiver from damage if your antenna gets too close to the transmitting antenna.

Note: there are some added benefits provided by the passive attenuator incorporated in this design. The

strength of the 4-MHz RF signal (plus harmonics) escaping from the attenuator is reduced by 10 dB. Also, the strength of out-of-band signals entering the attenuator is reduced by 10 dB, thereby reducing the amount of intermodulation interference generated by the attenuator. The latter benefit is especially helpful when this attenuator is used in environments with strong out-of-band signals, like neighborhoods with pager towers.

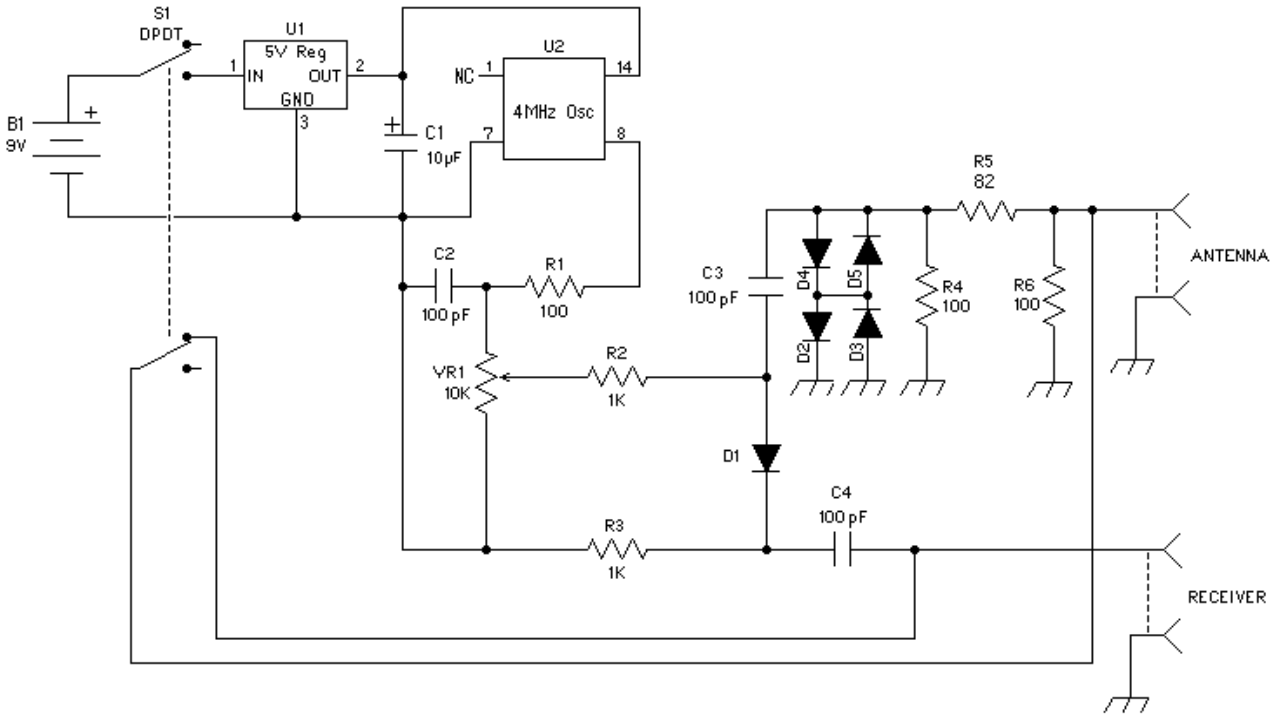

Figure 1: Schematic Diagram of Offset Attenuator

Part Identification

B1 - 9-volt Battery
Battery Connector (Radio Shack #270-324)
C1 - 10 uF 35 V Tantalum (Radio Shack #272-1436)
C2, C3, C4 - 100 pF (3) (Radio Shack #272-123)
D1, D2, D3, D4, D5 - 1N4148 (5) (Radio Shack #276-1122)
R1, R4, R6 - 100-ohm ½W (3) (Radio Shack #271-1108)
VR1 - 10K-ohm Linear Taper Potentiometer (Radio Shack #271-1715)
R2, R3 - 1K-ohm ¼W (2) (Radio Shack #271-1321)
R5 - 82-ohm ½W (Radio Shack #271-1107)
S1 - DPDT Switch (Radio Shack #275-614)
U1 - 7805 5-volt Regulator (Radio Shack #276-1770)
U2 - 4MHz Oscillator (Radio Shack #RSU 11321221)
Aluminum Chassis Box (Radio Shack #270-324)
Control Knob (Radio Shack #RSU 12130795)
BNC Female Chassis-mount Connectors (2) (Radio Shack #278-105)

BNC Double-male Adapter (1) (Jameco #127343)

Construction

This attenuator is simple enough to be built “dead bug” style, or it can be constructed on a small circuit board if you prefer. Enclosing the offset attenuator in a metal chassis is recommended. The shielding provided by the chassis will help prevent signal pickup through routes other than the direction finding antenna.

Substituting slightly different components is generally no problem with this design. However, parts placement can affect performance. The most common symptom of poor parts layout is a reduction in the maximum amount of attenuation the attenuator can provide. Another frequent symptom is a sudden dip in attenuation as VR1 is turned toward the maximum attenuation setting. Both symptoms occur when an excessive amount of 4 MHz signal is inadvertantly fed into D1 by one or more routes that bypass potentiometer VR1.

Ground loops, and stray capacitance between adjacent wires and components can account for the undesirable signal leakage into the mixer diode. The best way to avoid these problems is to minimize the lengths of the wires connecting B1, U1, U2, R1, R2, R3, VR1, C1, and C2. It can also help to locate those nine components as far away from the other components as possible. In really stubborn cases it may be necessary to place some shielding between the two component groups. Ground loops can be minimized by making sure that neither battery terminal has been connected to chassis ground.

Operating Instructions

Insert the offset attenuator between your VHF receiver and the antenna. When the attenuator is powered off, it will provide a minimum amount of attenuation caused by the impedance mismatch of S1. When the attenuator is powered on, it will provide approximately 10 to 15 dB of attenuation at all frequencies (you can adjust VR1 to vary the attenuation a little). When this amount of attenuation is insufficient, tune your radio receiver 4 MHz above or below the signal you wish to attenuate, and adjust VR1 for the desired level of attenuation.

Do not attempt to transmit through the offset attenuator. Doing so could damage the attenuator, or possibly your transceiver. Despite the protection provided by the clipper circuit, you should still avoid placing your receiving antenna extremely close to high-power (greater than 10W) transmitting sources.

References:

[1] "*An Active Attenuator for Transmitter Hunting*", Eenhoorn, Anjo, PA0ZR, QST, Nov 1992, p. 28
[2] "ACTIVE ATTENUATOR", Joe Leggio, WB2HOL: http://home.att.net/~jleggio/projects/rdf/a_atten.htm
[3] "Build An Offset Attenuator", Joe Moell, KØOV: http://members.aol.com/joek0ov/offatten.html

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