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The Loop-on-Ground Antenna For The Noise Challenged

In this article, we'll discuss the Loop-on-Ground antenna and how I've used it to advantage for mediumwave and shortwave DXing in an extremely RFI-ridden environment. We'll also discuss sources of RFI and how they might be minimized.

Those of us who have been in this hobby of DXing for many years are lucky to remember the days of no problematic electrical interference. My DXing days go back to about 1959 or 1960. It was about then that the modern-day light dimmer was conceived, using newly-developed thyristors and triacs to vary the "duty cycle" (on/off time) of the full AC voltage. It was the birth of the RFI avalanche.

Electronic hash proceeded quickly. Radio frequency interference (RFI) - the crescendo of noise on the bands - is becoming virtually impossible to identify and corral. Back in the 1980s when it started getting worse, it was still possible to identify sources and eliminate them using time-worn line-choke-suppression methods. Now, not so much. The genie is out of the bottle and it ain't going back in.

One of the best tools I have found to identify RFI is a spectrum analyzer. No, a $2000 unit isn't necessary. You already have one if you own an SDR receiver. I have an SDRPlay RSP1a, purchased at $119 U.S. and it's quite easy to take a look at any frequency from 10 KHz on up to see where the problem areas are. Spread a short wire across the floor in the house, connect it up, and you will see all kinds of mysterious RF. A pocket or portable sniffer receiver can work for this too but it's much easier to see the RFI's extent on an SDR receiver's spectrum display. The sniffer receiver is better used to locate the RFI.

I currently use my RadiWow R-108 as a sniffer receiver when walking around the house or property. This is used once the RFI "problem" frequencies are identified on the analyzer. Your Tecsun PL-380, PL-310, or other portable receiver can do the same.

The next two sections of this article, BIG OFFENDERS and ANTENNA SOLUTIONS FOR NOISY ENVIRONMENTS, are reproduced here for clarity, and as a re-introduction to low noise antennas. They originally appeared in my article The RFI Menace And Reduced Noise Antennas.

THE BIG OFFENDERS

Let's go over the big RFI offenders to our DXing. The big offenders at my DXing home are:

My Hewlett-Packard 24 inch computer monitor. Huge, wideband, low frequency buzzing in a range across the VLF, longwave and lower mediumwave bands, particularly in the 300-900 KHz segment. The switching power supply creates some of this but the majority comes right off the screen's surface when the display is lit. Efforts to reduce this RFI have only been mildly successful, but luckily its range is only about 15 feet. The downside is the radios need to be within 15 feet of the monitor, particularly the SDR.

My laptop's switching power supply. I have a recent (2020) Acer Nitro 5, 15.6 inch, with AMD Ryzen 5 4600H mobile CPU. Huge, wideband, low frequency hash between 0 and 600 KHz. Virtually all of this disappears when running on battery only. You can't run on battery forever, however.

Old style fluorescent lighting, particularly the old 4 ft. shop lights. Best is to just keep them turned off.

Light dimmers. Don't use them. Keep them off or remove them.

LED light bulbs for house lighting. The bad ones create a high frequency hiss. Luckily the range is only a few feet, but the house is full of them now due to power saving measures. Use good quality LED bulbs. Philips has been highly recommended.

Low voltage lighting used in the kitchen. Lots of wiring through the walls go to a transformer box in the cellar. When the lights are on they inject an additional huge buzz at the lower end of the mediumwave band, peaking at about 550 KHz. The emissions from these range throughout the house. The condition is virtually eliminated by keeping the lights off.

A myriad of switching "chopper" style wall transformers. Some are much worse than others. Try to identify the worst offenders. I try to put all of these on power strips so I can switch them off when not in use.

Unknown sources of frequency spikes. Strong 10 KHz spaced spikes from 9 MHz to 16 MHz, peaking in the 9.5-9.9 MHz and 10.7-12.5 MHz area. This one is intermittent. It can last ten minutes or an hour or more, then disappears. ~~I have not ruled out that this signal may be coming from the mains feed to the house.~~

**Note: this RFI source just above has been identified. It comes from a $2000 Fisher & Paykel kitchen refrigerator. Fisher & Paykel is a major appliance manufacturer which is a subsidiary of Chinese home appliance manufacturer Haier. It is a multinational corporation based in East Tamaki, New Zealand. In 2012, Haier, a major Chinese appliance manufacturer, purchased over 90% of Fisher & Paykel Appliance shares. Partial solution: wrapping the power line cord through two Workman RFC-1 snap ferrite cores has reduced the problem 50%. More cores have been ordered.

A new 43 inch Toshiba smart TV and DISH satellite box combo. Tremendously strong RFI, a high-pitched squeal in the LW and MW bands coming out of these boxes out to a 6-8 ft. radius, which then couples to lines. It might be possible to put these on a switchable power strip, but then you have the device reboot problem every time you want to use them. Satellite box boot time is often 5 minutes. That's a no-go.

Those are just the biggest offenders. Not mentioned is the RFI coming off the computerized de-humidifier in the cellar, the computerized water conditioning system, and the two computerized heat pumps hanging off the back of the garage.

So you can see the frustration. It's not practical to try to eliminate all of this RFI unless you'd like a lifetime career in RFI removal. I suspect this is the case almost everywhere.

ANTENNA SOLUTIONS FOR NOISY ENVIRONMENTS

Being a ham as well, I've experimented with just about every wire antenna you can imagine over the last 60 years. My days of winding power line chokes are over. Common-mode chokes, current isolators, et al, are the rage these days - these to reduce RF pickup on the feedline and to lessen the possibility of the feedline from becoming part of the antenna system. They can help, but they are a Band-Aid to the real problem. Why not lessen the noise in a different way? My solution is to build inherently quiet antennas which are resistant to noise, *and feed them correctly*.

Three things are important.

1. Get the antenna well away and out of your house.

An end-fed longwire attached to your shack window fed with 15 ft. of coax across the floor isn't going to do it. If possible, on your lot, put the feed point as far away as you can. This, for starters, is one of the most important things you can do. Don't worry about cable feed length. Coax feed at mediumwave or even shortwave frequencies has minimal loss. 100 feet of the old 50 ohm RG-58 on mediumwave presents only about 0.37 dB signal loss, virtually unnoticeable. RG-6A TV coax, 75 ohm, is even less at about 0.28 dB per 100 ft. I use RG-6A here almost exclusively, as it is cheap and readily available through many suppliers.

So, get that feed point as far away from your house as possible.

2. If you can, choose an antenna that is basically a short circuit. *What did you just say?*

Loop antennas are essentially short circuits to high frequency impulse noise. Long wires, verticals, and dipoles are not. They are RFI magnets, and particularly so if they are not balanced antennas (the dipole is at least balanced). Much of the high frequency noise component of RFI is short circuited in the loop. Small loops are even better for noise suppression, but their drawback is they often need active amplification due to lower signal delivery. Loops work well when placed close to the ground and you don't need high supports for wires.

They can also be laid flat on the ground itself which reduces RFI even more. This is where our Loop-on-Ground antenna will come in.

3. Use an isolating transformer *at the antenna feedpoint*. Very important. Feed any antenna with a transformer-balun isolating device, even if it is naturally a 1:1 match. There must be no common ground connection between the coax feedline and the antenna, i.e., between the primary and secondary of the transformer-balun. The antenna should remain floating and the coax remain floating. This isolating-matching device does three things which help abate noise:

1) Matching the antenna greatly increases received signal strength. Increasing signal strength often will raise the signal above the noise floor. Remember when receivers had preselectors to peak the antenna, which made the difference of hearing a signal or not? This is what a broadband matching transformer is actually doing - matching the antenna to the receiver across a wide range of frequencies.

2) The transformer, at least the one we will use, totally isolates the antenna from the receiver, eliminating the direct wire connection and lessening RFI *picked up by the antenna* from transferring to the coax. Much of the RFI will be consumed in what I call the secondary, or load side (antenna side) of the balun, as it appears as a direct short to the high frequency component of noise.

3) The transformer/balun reduces antenna loading because it presents a proper load impedance to the antenna. Loading down the antenna destroys bandwidth and lowers signal strength. Take a longwire for example. A longwire antenna has an inherently high feed impedance, generally 450 ohms, nothing near the usual 50 ohms of a receiver. With no matching device, the input signal delivered to the receiver is a simple resistance ratio. The signal is delivered through a 450 + 50 ohm series divider. The receiver gets 50/500ths of the available signal without the proper transformation. That's 1/10 of the signal being picked up by the antenna! No wonder my receiver can't hear!

THE LOOP-ON-GROUND ANTENNA, or LoG

Now we get to the Loop-on-Ground antenna, or LoG. The LoG antenna is another variation of the close-circuited loop, only it lays flat on the ground. It is also best fed with a balun. KK5JY has the preeminent article on the Loop On Ground antenna, with illustrations. Be sure to check it out. It is the inspiration for my Loop-on-Ground which I use for mediumwave and shortwave.

http://kk5jy.net/LoG/

KK5JY's LoG antenna performs best from about 2-8 MHz, at about 60 ft. total wire length. Wanting to try a LoG for mediumwave, I decided to buy a 100 ft. spool of insulated, 18 gauge wire. These are readily available from Amazon for about $9. I ordered one and experimented.

KK5JY, being a ham, based his design on covering the 160, 80, and 40 meter ham bands. We will increase the loop size to cover the mediumwave band. It will be effective all the way up to the 31 meter band and beyond.

The Nooelec 9:1 balun connection

The LoG is generally arranged in a square and fed at one corner. It is somewhat directional, having an extremely flattened hourglass pattern, with slight nulls at the feed corner and the corner opposite the feed. In practice I have found its directionality hardly noticable. Both high and low angle reception are good, within its range, with high angle being predominant. Studies have shown that the pattern is similar to a big ball set on the ground.

Don't have concerns about low angle reception. As I write, I am tuned to 530 KHz at 3 AM in the morning here on the east coast of the U.S. On the channel fighting it out are CHLO-530, Brampton, Ontario (193 km @ 250 watts), and 530-Radio Encyclopaedia in Cuba (2300 km).

Best results are when the overall loop length is about 15% of a full wave for the frequency of interest. As stated, a 60 ft. total length works well for the 2-8 MHz range. It is usable to about 15 MHz, though sensitivity drops off above the 25 meter band (11.500 - 12.200 MHz).

Initial testing for KK5JY's 60 feet of wire on the ground were not encouraging in the mediumwave band. Signal strengths were down except at the very high end. 100 feet total wire length works out to an optimal 1480 KHz, and greatly increases the signal strengths throughout mediumwave. 120-140 feet should be even better. Ballpark ranges are thus: 530 KHz - 278 ft., 1700 KHz - 86 ft.

Lay your 100 ft. of wire out in a square, 25 ft. to each side, and feed it at a corner. Exact square shape is not paramount, but try to keep it as close to square as possible. Remember, loop area is important - we want as large an open area as possible. The loop can be layed right on the surface of the ground or pinned down with U-nails. Some have even dug it in an inch or two. This winter, mine has even been buried under 12 inches of snow for the last month, and the LoG has still performed admirably.

The loop must be fed with a balun and remain ungrounded. KK5JY's 2-8 MHz loop exhibited a feed impedance orbiting the 400 ohm range. That's about 8:1 for a 50 ohm coax feedline. I'm using a commercial Nooelec 9:1 receiver balun, available from Amazon for under $20. It has proven to be close enough, though I'm planning on experimenting with different homebrew toroid cores and turns ratios. My loop is fed with 100 ft. of RG-6A coax (75 ohm), though I've experimented out to 175 ft. I've found the 100 ft. minimum distance from the house to be adequate in relieving 95% of the noise problem. It is important not to ground any leg of this antenna as that will upset its balance. Also do not earth-ground the coax shield. Early models of the Nooelec 9:1 balun (v1) joined the primary and secondary windings electrically through a center-tapped secondary. Be sure to get the new version of the Nooelec balun. They have eliminated this connection.

The Nooelec Balun One Nine (v2)

The LoG is an excellent low noise performer. My 100 ft. length lying on the ground shows close to 15 db less noise than a 6x12 ft. flag antenna, with about equal signal strengths. Similar results were found with tests in the tropical band (60 meters). The difference gained is in the substantially better signal-to-noise (SNR) ratio. A 15 dB reduction in noise while holding the same signal strength as the small flag antenna is a 15 dB SNR improvement!

The antenna is fairly non-directional, so no competition is claimed with the directional beverage-on-ground (BoG) or traditional above ground beverages. Internet reports have made the claim it works well in some localities but maybe not so well in others. Discussion of ground conductivity under the LoG then ensued, with pros and cons. I suspect many dismiss it outright without really doing a little deeper experimentation. Initial reaction is always "how can this work if it is lying on the ground?"

Signals need only to break the atmospheric noise level by a few dB to be received. But first you must lessen the electrical hash so it is below that level. With the LoG, general atmospheric noise levels here are well under a microvolt from MW through 30 MHz, somewhere in the -110 to -120 dBm area, depending on the band. Remember, -107 dBm is one microvolt signal level, a very small signal. Check out KK5JY's page where he has produced some signal graphs.

LET'S SEE SOME RESULTS

The best way to show off the LoG antenna is to show its reception advantages on an SDR's spectrum and waterfall displays. Using an SDRPlay RSP1a and SDR-Console gives a dramatic result.

<u>BEFORE</u> - SDR using a 100 ft. longwire, run from shack window out to a tree. Longwire fed at the window through an RF Systems Magnetic Longwire Balun to a short length of coax to the receiver. The electrical hash is deafening, as seen in the waterfall.

<u>AFTER</u> - SDR using the Loop-on-Ground antenna and fed with 100 ft. of coax. No hash.

We are tuned to 530 KHz in both examples. It's 3:14 AM in the morning in western New York (display time is in UTC, 08:14).

In the first example, on the 100 ft. longwire, look at the broadband electrical hash saturating the band. It is running S5 on the scale at left. There are signals there at the S8 level, but they are not intelligible due to poor signal-to-noise ratio.

Now, look at the second example, using the LoG antenna. No electrical hash. What you see on the spectrum display is the atmospheric noise level, just above S1, about 0.3 microvolts. The signals at 530 KHz are at S8, and we have multiple signals. In the headphones are two stations: On the channel fighting it out are CHLO-530, Brampton, Ontario (193 km @ 250 watts), and 530-Radio Encyclopaedia in Cuba (2300 km).

The difference is in bettering the signal-to-noise ratio. In the LoG example, signals are a full seven S-units out of the noise, proof-positive that an antenna lying on the ground can work.

Again, don't worry about low angle reception problems. 530-Radio Encyclopaedia in Cuba at 2300 km has a calculated arrival angle of about 7 degrees.

I also enjoy SWLing. My 100 ft. LoG is effective to the 31 meter shortwave band and beyond to 25 meters. Better results for higher frequencies can be had by shortening the wire length some. One of my favorite things to DX is Asia as the sun sets there. If conditions are good, signals just pop on the 31, 41, and 60 meter bands with the 100 ft. LoG. Right now I am tuned to the BBC/English service at Kranji, Singapore on 9580 KHz (125 KW) as I write at 1115 UTC (15,100 km distant). They are arm-chair copy.

An excellent 16 page thread discussing the LoG antenna and matching techniques can be found on the QRZ forums. It is well worth a read.

https://forums.qrz.com/index.php?threads/loop-on-ground-antenna.622669/

Testimonial from that thread:

"Give it a try and post back here with results. I would like to hear how it works out for you. Just do not panic when you first hook up the antenna. Initially it will look like a Dumb (Dummy) Load because there is no noise, and signal levels will be down. But SNR (signal-to-noise ratio) levels will more than make up for signal loss. A signal level of -100 dBm is a HOT signal when the noise level is down at -140 dBm, that leaves you 40 dB SNR, a crystal clear signal."

FEEDING A POCKET OR PORTABLE RADIO HAVING NO EXTERNAL ANTENNA JACK

For the MW broadcast band, feeding the LoG or any low noise antenna to a pocket or portable radio is easy. I find inductive coupling best.

Salvage a short ferrite rod or bar from an old pocket radio. Three inches in length is about right. Remove all the magnet wire from it. Using some solid, insulated telephone wire of about 24-26 gauge, wind about 15-20 turns close-wound around the ferrite rod. Solder or clip the two ends of wire from this coil to the coax feeder coming from the antenna, one to the center and one to the shield. Hold the ferrite close to the radio's internal ferrite which will inductively-couple the signal to the radio. The advantage over a passive loop here is you have a broadband antenna which does not have to be tuned.

Ferrite coupling

ADDITIONAL READING

Fabricating Impedance Transformers for Receiving Antennas, by John Bryant:

https://www.qsl.net/wa1ion/doc1/z_transformers.pdf

Broadband Receiving Antenna Matching, by Mark Connelley, WA1ION:

https://www.qsl.net/wa1ion/bev/bb_antenna_matching.pdf

WRAP UP

I would encourage many of you with RFI problems to try the Loop-on-Ground antenna. Don't dismiss it just because it lies on the ground. Cut to the right size, the LoG can be effective anywhere from longwave to 30 MHz. Experiment!