Natural Radio

News, Comments and Letters About Natural Radio

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Power Line Noise Revisited – Natural Radio Listening is a simple hobby, at least on the surface. The equipment is simple; all that is required is a high gain audio amplifier and a set of earphones. No tuning, frequency conversions, or exotic components are required. Your local Radio Shack has everything needed to build a simple receiver. But there is a major barrier to hearing Natural Radio Signals and that is power line noise.

The harmonics of the 50 and 60 Hz. power mains permeate the whole band of Natural Radio signals and in most urban and suburban locations make listening impossible or very difficult. For those that have access to remote, unpopulated locations, they can get in their car and drive up a mountain or out into the desert and within an hour drive find a good listening spot. For the rest of us this noise is a real problem.

There are hardware and software solutions available for filtering out the fundamental power line frequency and its harmonics, but in an extremely electrically noisy place, like most urban and suburban residential neighborhoods, their utility is far from ideal.

My interest in this was re-kindled as I was working on a training program last week for a client that helps people evaluate the efficiency of their energy source. In Illinois and many other places, the transmission and distribution of electrical energy has been separated from its generation and we have the option to purchase power from a variety of sources, while retaining our current transmission and distribution system. Now of course the electrons from different suppliers are not routed separately down the lines, but the overall mix of power in the grid, comes from different suppliers in proportion to the choices that consumers have made.

You can choose your source based on cost, efficiency or other factors. The program I was working on outlines a rating system that would let you evaluate a supplier based on efficiency of generation and distribution. I discovered that transmission and distribution losses are typically between about 6% and 15% of the generated power. So I thought it would be easy to look up where these losses come from and find some data on how much power was actually being radiated from the lines. But as often happens, I was wrong.

There is virtually no information available on the percentage of energy that is radiated from power lines, and I assume that is because it is very small compared to the losses in the resistance of the lines and in the losses in transformers.

But while the radiation may not significantly affect the losses of power transmission and distribution, it is strong enough to cause serious disruption of the reception of whistlers, chorus and tweeks.

Almost all of the information I found on power line radiation was about the health effects of magnetic fields in the vicinity of power lines. No reliable study has shown any correlation between illness and living near power lines, but there is still plenty of controversy about the issue. It was certainly an interesting subject, but not what I was looking for.

Power lines can be roughly divided into two categories, transmission lines and distribution lines. Transmission lines carry the power long distances between the generating source and a power station or substation. They are almost always three-phase and operate at voltages exceeding 100 KV. in order to minimize the resistive losses in the lines. Distribution lines are lower voltage and get the power from the substation out to the consumers.

Conventional wisdom in the Natural Radio world has always been that high-voltage transmission lines are more of a problem, than the distribution lines that run into neighborhoods. However, I am beginning to question that for a couple of reasons.

First of all, if the 50 or 60 Hz. radiation of the power line were the only problem, it would be very easy to filter out, and its filtering would not cause a loss in quality, since it is below the frequency of most of the signals that we want to listen to. It is the harmonics that cause the bulk of our problems and they extend upward through the whole audible band of the Natural Radio frequencies. These harmonics are caused by non-linearity on the distribution lines such as arcing brushes on motors, sodium and mercury vapor lamps, fluorescent lamps and their ballasts, various solid-state devices and all the other things we plug into our outlets that are not purely resistive loads.

Power transmission lines are balanced lines and are carefully matched to their loads. So like an RF transmission line that is matched to an antenna, they don't radiate very much. Also, there should be few non-linearities on transmission lines and thus low harmonic generation.

So, my guess is that distribution lines are more of a problem for us than transmission lines, at least for frequencies beyond the fundamental of 50 or 60 Hz. But this is just a hunch as I don't really have any data to substantiate this hunch.

Since I haven't been able to find any good data, the the only thig I can do is to go out and make some measurements. My plan is to build an simple small loop and connect it to the balanced microphone input of my zoom H4N recorder and make some recordings while standing under transmission lines and distribution lines.

I will then do spectrum analysis of the recordings and try to determine the harmonic content, versus fundamental content of the different types of lines and see if there really is less harmonic content on transmission lines.

I'm not sure if I will find any useful information from these measurements or not. The issue of power line radiation is extremely complex. A wavelength at 60 Hz. is about 3100 miles! So near-field radiation for power lines probably extends for miles and calculating it is much more difficult that the simple $1/d^2$ formula for far-field radiation. Also, the complexity and criss-crossing of the power grid makes any kind of modeling or calculation very difficult. It's not as simple as predicting the performance of a dipole antenna.

I'll be making some measurement and spectral analysis over the summer. If these crude measurements prove useful, I'm sure I'll find more precise measurements that will provide more useful knowledge. The ultimate purpose is to try and develop some criteria for finding a quiet listening spot. The secondary purpose is just pure curiosity.

If any readers have any links to articles on low-frequency power line noise, or have made useful measurements, I would welcome that information. Stay tuned.