Brass Tacks

An in-depth look at a radio-related topic

Noise

You finally got your HF act together, so once you got your General license, you went online, got a new HF rig, power supply, tuner, nice dipole antenna, low-loss coax, and taped the ARRL band plan to your wall. Congratulations...you're ready to move into a bold, new world. You flip the switch to the PSU, fire up your radio, and suddenly you're surprised at what you hear: hissing, static; in short, *noise*. Sounds more like a room full of librarians continuously saying, "shhhhhhh!" Instincts kick in, and you start fiddling with knobs, only to make it worse. Finally, you decide that you've purchased a lemon, and start looking for the receipt. It just doesn't sound like the safe, quiet world of squelched FM that your Technician license cradled you into.

Well, before you go drowning yourself in depression, let's do a little experiment, shall we? First, go get a good battery, connect your rig and your tuner to it, and turn off your power supply. Ok, not much changed. Now, locate your electrical service box and completely switch off the power to your house. Yep, furnace and fridge and everything. Suddenly, the noise level from your rig's speaker has lowered noticeably, and you start feeling better about the quality of your radio. But the staticky noise is still there, just not quite as loud as before.

Encouraged, you sneak next door, and turn off your neighbor's power, then run back to your rig. Wow, even less noise. And then another neighbor, then another, and another. With each house power shutting down, you experience a small reduction in the noise coming from your radio speaker. But it finally starts dawning on you where all this noise and static is coming from, so you go turn everybody's power back on before the cops arrive, haul all your radio gear out to your car, and head a mile out of town. And just to make sure you and I are on the same page, *nothing in this article has anything to do with transmitting, only receiving*.

Away from your house, you once again set up your station, turn on your radio, and in the absence of much of that static, you suddenly start hearing stuff you haven't heard before, like QSOs, and CQs, and foreign languages from distant shores. The noise is still there; at least now you can work with it. But you want it all, so remembering an important lesson, you find a way to get your dipole up 20 feet off the ground. Even less noise! You raise it to 30 feet, and the noise is even smaller.

You put it up a full 40 feet, and you've just about reached heaven, when nearly all of the noise coming from your speaker that you heard previously at home is now gone. In fact, tuning around the bands, you can clearly pick up two stations that seem to be walking right over each other, one from Phoenix and the other from San Francisco, but it's obvious each station can't hear the other. Why did raising the dipole make the noise go away? Is it because now the antenna is farther away from the noise sources? Possibly, but more likely it's due to a change in your antenna pattern.

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Ok, now at least you know that your receiver actually works, and now you know why the signals sound so much better out at Field Day. But to set up your station like that every time you want to get onto HF is impractical. Rest assured that there are steps you could take, to help reduce this phenomenon that's been hiding all these good signals from you.

Before we can solve this problem, let's ask one pertinent question: where is all this noise coming from? It comes from computers, from wall warts, from chargers, from flat-screen monitors and TV sets, from motors in refrigerators and furnaces, from dimmers and light switches being tuned on and off, from toys, from fluorescent light fixtures, from cordless phones, from microwave ovens, and lately, from LEDs. Does your home have these? How about your neighbors? Of course they do. And if any of these things is defective, it can put out a tremendously higher level of noise than it normally would.

In order to keep this article short enough to enjoy (it's already too long!), I'm going to oversimplify the solutions just a bit, but I believe you can still benefit by what we're talking about here. In a nut shell, the focal point of all this noise is your antenna. In other words, your rig, your tuner, even your coax and power supply can pick up a little noise, but negligibly compared with your antenna. After all, that's the purpose of your antenna, right? But you need to hear the other stations because, as the old saying goes, ***If you can't hear 'em, you can't work 'em.*** There are three basic things you can do to reduce the amount of noise you bring in through your antenna.

LED billboards, an increasingly popular noise source

Remove local noise sources

It's not realistic to believe you can unplug everything in your house every time you get on HF and work DX. Remember you still have your neighbors, and their noise sources, to deal with too. But you can start with an in-home witch hunt, by turning off your house power while your radio is on battery, and one by one, turn on each breaker until you find one that's more responsible for your noise than the others. Then with that breaker on, but the attached appliances unplugged, plug each back in until you find an excessively noisy device. This will require a lot of patience, especially from your spouse.

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Reduce noise from local sources

A bit more expensive, one thing you can try is filter out noise coming from your various home sources, by installing a low-pass filter on your coax near your rig. Or you can try a band-pass filter, to allow only signals near your frequencies of interest to arrive at your radio. An RF isolator is a good device that helps reduce noise, and they're inexpensive. Some types of (current) baluns serve as RF isolators. Even more expensive is standalone DSP (digital signal processing) filters you can purchase. Another thing you can do is snap a number of ferrite beads on all the wires attached to your rig, such as the power cord, your coax, your tuner controller, computer interface, and so forth.

Ferrite beads

Many of today's most recent rigs have DSP built into the receiver, and that helps tremendously. In fact, ever wonder why some amateur radio transceivers cost more than ten grand while other very good and popular ones go for under a thousand? You might have assumed it's because of their pretty displays and handy computer interfaces, and that's true to some extent. But probably the largest contributor is their very high-tech and excellent noise filtering. If you're absolutely serious about working DX, and are ok with taking out a second mortgage, then nothing short of one of these bad boys will do.

The Icom IC-7851, which retails at $12,500

At this point some will mention the importance of a good ground, but I'm going to tell you that the purpose of your ground is not to improve your signal, unless you're using an end-fed or ground-mounted vertical. In most cases, if you find that installing a good ground improves your signal, you don't have a ground problem; you have an antenna problem that you're hiding, and chances are, you've improved your antenna, not lowered your noise. That being said, I do highly recommend that you install a good grounding system, for electrical shock prevention, lightning protection, and peace-of-mind, if not for noise reduction.

Adjust your antenna pattern

Let's take a look at that dipole of yours and ask, what is its antenna pattern? If it's 15 feet off the ground and you tell me it has a characteristically sideways toroidal shape, with nulls in the direction of the wires, you're sadly mistaken. At that height, it's omnidirectional. You get it up 1/4 wavelength off the ground (33 feet for 20 meters, 66 feet for 40 meters) and then it starts looking like the sideways toroid you've seen in pictures. (By the way, for ideal DX working, you should get your dipole up a full wavelength, which is 66 feet for 20 meters and 130 feet for 40 meters. Yikes!) Also, this all assumes a flat-top configuration. If you use a sloper or inverted-V

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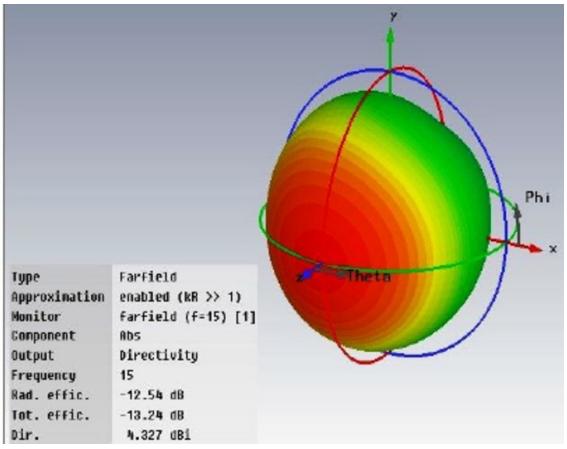
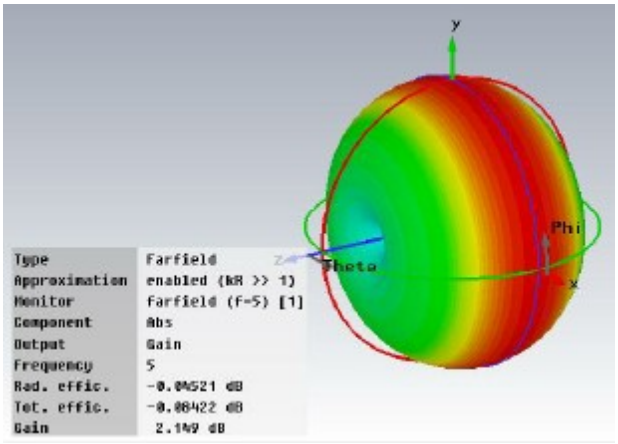
dipole, you need to get it up even higher to avoid an omnidirectional or ellipsoidal pattern.

Next question is, who cares what antenna pattern your dipole has? Your antenna pattern is an image drawn by the vectors of electromagnetic energy emanating from your antenna. If you remember the Reciprocity Theorem in Physics, you'll recall that ***the far-field receive pattern for a given antenna is identical to its transmission pattern***. Interpreted, that means if your antenna transmits better in some directions than others, chances are that it will receive better from those same directions than from others. So, which antenna pattern will collect more noise, one that is omnidirectional (picks up noise equally in all directions) or directional (picks up much less noise from some directions than from others)?

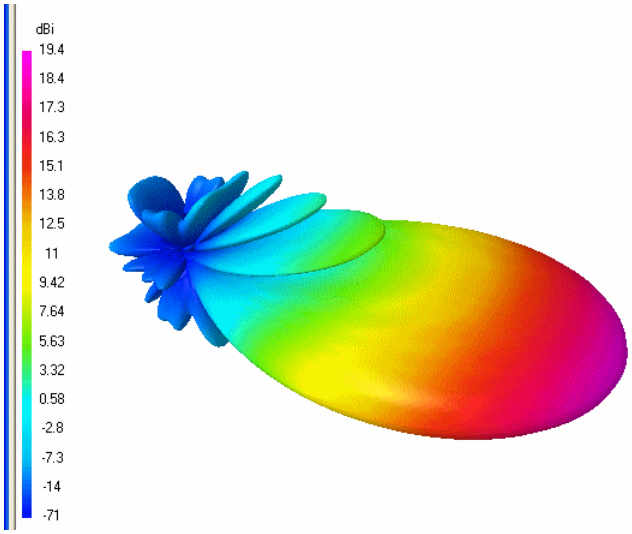


Low dipole—omni-noisial

Getting your dipole up higher has two advantages: transmits your signal better broadside to your antenna and picks up less (attenuates) total noise. This is why vertical antennas tend to be noisier than directional antennas: they bring in noise from sources all around. This is also why hams who use Yagi (beam) antennas can pick out a difficult QSO so well: their directional antennas essentially allow only the noise they're pointing at, to come into their rigs. Remember the two stations from Phoenix and San Francisco talking over each other? With your beam pointed at San Francisco, he comes in booming to your station, while the signal from Phoenix is now treated as noise, and you can just barely make him out.



High dipole—less noisy



Beam antenna pattern—sweet and quiet

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One last thing: power line noise. For a second, think of the zillions of blood vessels routing through your entire body, carrying Oxygen to each and every living cell. Now, instead of blood vessels, think of power lines. Instead of cells, think of homes. And instead of Oxygen, think of noise. Yeah, the power lines carry power, but these world-wide and world-sized antennas also pick up and carry noise. And I'm not talking about a 60 Hz AC hum either. I'm talking about a noisy laptop charger in Ohio whose *dirty* signal gets carried into your home in Pleasant Grove.

Yeah, I realize that Rocky Mountain Power, et al, attempts to do some filtering, but their focus is on sine wave preservation at very low frequencies. So, most RF noise coming into the grid is fed directly into your home with little to stop it. Line filtering and *conditioning* of your own can help, if you find that the grid is bringing a lot of noise into your home or antenna.

Conclusion

So, solving noise issues on HF is as old as radio itself. Noise is always going to be there, but we can take steps to reduce or eliminate much of the noise by either attacking the noise sources through a witch hunt or filtering, or by changing our antenna pattern. And if we're using a dipole or beam antenna, we can eliminate more of that noise by raising the antenna height to control its pattern. While an omnidirectional antenna will collect noise equally from all around, a directional antenna will collect much of its noise from only its beamwidth, and attenuate the rest.

In the end, you might just discover that you have one major source for your noise: your collective neighbors. If that turns out to be the case, and you've done pretty much everything else we've discussed here, probably the only solutions that remain are

1) work HF by going portable (away from home) as time permits,
2) stick with 2 meters, or
3) move.

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