The Elmer's Shack: Some Antenna Basics
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Welcome to the first edition of a new column focused on the sharing of information, advice, and experiences between hams, particularly with the goal of helping one another enjoy this great hobby. While there will be a definite focus on helping newcomers to the hobby, what really happens is that all of us learn from one another. Regardless of the number of years one has been a ham there is always much more to learn. Amateur radio has a proud tradition of hams helping hams, and that is just what we intend to do here.

With those thoughts in mind let me say here that your ideas, suggestions, and experiences are welcome, nay *encouraged*, so that we can meet real needs within our group. If there are topics you would like covered, let me know. If you have helpful tips, ideas, or practical suggestions which might benefit other hams, let me know. Newcomer or old-timer, your experiences matter and I hope you will share them with us!

Antenna Efficiency: Loss And Directivity
For those who are new to radio antennas in general, and especially for those who want to use an Amateur Radio station, antenna efficiency is an important yet often misunderstood concept. Many antenna manufacturers make a lot of claims about their particular antenna, most of which are true, but some manufacturer claims stretch the truth just a wee bit. These manufacturers know many folks only look at a couple of efficiency statistics in evaluating an antenna, and so those numbers sometimes get inflated using theoretical numbers rather than real-world results.

Before I get to antenna "gain", one of the most popular numbers in assessing an antenna, I want to talk a bit about antenna efficiency from two perspectives: first, as a measure of efficient loading/matching of the antenna system, and second, as a measure of its directionality.

Line Loss
Power coming out of a transmitter is determined by the capabilities of the radio itself: a 100 watt radio operating at peak power will send 100 watts out the coax (or "feed") line and on to the antenna (or radiator). Immediately a bit of loss is introduced by the feed line and by the antenna fixture itself as the RF power encounters resistance from the materials used to conduct the RF signal. Assuming a quality feed line, a reasonably short run of that feed line, and a match between the antenna, feed line, and the radio, the loss will be minimal. Of course, as I have discussed in the past,

antenna height, the surrounding terrain, and atmospheric conditions will all play a role in how far the signal travels and who is able to hear you.

By far the greatest cause of power loss is an inefficient or poorly matched feed line. RF lost at the feed line turns into heat, which is then dissipated out of the coax. A high SWR reading at the antenna does not mean power is not getting out to the antenna—it will eventually get radiated as long as there is minimal feed line loss. Watch out for poor solder connections, breaks in the shield braiding, or broken wires. Also make sure the coax line you are using is a good match for the frequencies you will be using it for—always try to use the highest grade coax you can afford so as to ensure minimal line loss.

A second and very important cause of power loss/low efficiency is ground effect, particularly at the radiation source. Near-field reactivity can greatly affect the amount of signal that gets radiated from the antenna. An antenna can act as an inductor or a capacitor depending on its interaction with ground. This means that the signal can either get a boost or suffer loss depending on ground conditions near the antenna and its height and orientation above ground.

Reflected RF energy from the ground can help or hurt the efficiency of an antenna depending on whether or not the reflected energy is in phase with the upward radiating signal. Therefore antenna efficiency is in some ways more than the sum of its parts; various elements must be taken into account when determining what works best under what conditions, including the actual design of the antenna itself. This is where *directivity* comes into play.

Directivity

Antenna efficiency is also determined by how the power is distributed or directed through the antenna. An omni-directional antenna radiates the same in every direction (this is speaking theoretically of course; no antenna can be fully omni-directional). In this case if 100 watts of power is applied to the antenna, 100 watts goes out in an omni-directional pattern—that is, a total of 100 watts goes out equally in all directions.

By contrast, this same 100 watts when sent out by a beam antenna gets concentrated in one general direction over the others. Keep in mind, no antenna design is 100% efficient. While the power is significantly concentrated in one general direction with a beam, some power will still go out in other directions, and this is to be expected even with the most efficient beam on the market. For our purposes here, it is sufficient to say that a directional antenna is more efficient than an omni-directional antenna. However, both have their uses.

Another way of thinking about this issue is to think of a bare bulb casting light in all directions. The bare 100 watt bulb distributes light evenly as power is applied. When a reflector is placed around the bulb the same 100 watt bulb now becomes directional as the reflector directs light forward. A satellite dish is a good example of this concentration of energy—the dish is a large reflector focusing the RF energy into a relatively small area.

Antenna Gain

Antenna gain is a much misunderstood term because true gain only really occurs when power is added to a signal through some means, such as with an "Active" antenna. What most people refer to as gain is really a combination of directivity and efficiency. Antenna designers shoot for a desired radiation pattern for a given application (directivity), and then seek to minimize feed line and ground losses to use the power most efficiently. All gain figures are comparative—one antenna is compared to another, usually in theoretical terms, such as a 3-element Yagi in comparison to an isotropic antenna. Remember that an isotropic antenna is a perfectly efficient, lossless imaginary antenna in free space. When a dipole antenna is compared to an isotropic antenna, it is considered to have a gain of 2.15**dBi**, the "i" standing for isotropic.

This is where things get a little tricky, especially if you are a manufacturer wanting to make your antenna look better than it might really be! When gain is given in dBi people often forget this is referencing a "perfect" antenna, something that does not exist in the real world. As a general rule of thumb, one should get in the habit of subtracting 2 from the gain number given when it is in dBi, because what we really want to know is how this antenna compares to an omni-directional dipole antenna. Thus if the manufacturer says an antenna has a gain of 3dBi, it really means it only has a gain of about 1dB over a standard dipole (2.15dBi).

If a manufacturer lists gain in terms of **dBd**, then the comparison is being made to a dipole already, and this is a much better indicator of real-world gain (of course this assumes honesty on the part of the manufacturer—this is why there is no substitute for empirical testing!) A gain of 3dBd means an actual gain of 3dB over a dipole.

Wrap-Up

This is just a brief introduction to antenna efficiency, directivity, and gain, but I hope it spurs you on to further studies. Antennas are a fascinating subject, and learning about them can last a lifetime! 73, Robert