HF Amplifiers versus Antennas—One Ham's Opinion

Think you need a shiny new linear amplifier to chase away your HF radio blues? Think again. What you probably need is a better antenna! Here's why....

By Kirk A. Kleinschmidt, NT0Z, 16928 Grove St, Little Falls, MN 56345, kirk@cloudnet.com

Let's start by eliminating any thoughts of fairness and equality regarding this article's handling of the age-old philosophical struggle between amplifiers and antennas.

More than a few hams will take exception to my biased statements (common when trampling sacred cows and sneering at tradition), but if you're a typical beginning ham, you're probably wondering whether to buy an amplifier or improve your antenna system—or maybe both.

It's a logical question. You want to improve your station's signal quality, make more QSOs, work more DX stations, rack up higher contest scores and chat with others while enjoying armchair copy.

You want to know whether amplifiers are a good investment, whether they'll require additional equipment and services, whether they'll provide the boost in readability you've been desiring and so on.

By now you're thinking that I'm an "antenna guy," and that I'm here—through this article—to persuade you to improve your antenna system. You're right!

But beyond the many nuts and bolts reasons detailed herein, I'd like you to at least consider a few philosophical reasons to keep your power output at barefoot levels (or less!). Then, if you're not convinced, we'll take a look at the cold, hard facts about amplifiers and antennas.

Amateur Radio's Middle Path

Amateur Radio operation in the US is constituted as a radio *service*, with rules, regulations and goals that go beyond the interest of mere hobby operation. In becoming licensed hams, we agreed to play by those rules. One of the most important rules compels us to use the minimum transmitter power required to communicate.

That doesn't rule out the use of linear amplifiers, of course, but it does put a damper on their indiscriminate or *habitual* use. Powering your amplifier through your shack's light switch certainly violates the rule, as does running maximum legal output power when chatting with the gang across town (or when propagation clearly doesn't require it).

The minimum necessary power rule is designed to protect us all. It promotes responsible, considerate operation. Try it sometime! Reduce your 100-W signal to 50 or 25 W. Thanks to years of low-power operating, I *know* that you'll maintain effective communication *most* of the time. You'll also improve your operating skills, enjoy a greater sense of achievement and gain an intuitive sense of propagation.

By the way, the FCC's minimum necessary power rule isn't suspended for contest operation, to work DXpeditions, etc. About the only open-and-shut case for the automatic use of maximum available power is for emergency communications. When someone's life is on the line, the more power the better. That kind of service is what the Amateur Radio Service is all about.

Skill Versus Brute Force

Long before David and Goliath had their epic battle, skill has been tangling with brute force. I'm sure you have your favorite analogy. Basically, it comes down to the fact that any idiot can fire up a water-cooled Voice of America-size transmitter and blurt out a whopping signal. I place hams who take this approach in the same category as the guys who screech the tires on their 1-ton pickups or water their lawns during drought emergencies. Both are equally impressive, I'm sure.

On the other hand, if you align yourself with the Davids of the world, substituting skill and persistence for brute force, you'll be in better company—and you'll be upholding the tenets of the Amateur Radio Service.

The Golden Rule

Hams treading the Middle Path are concerned about others—hams, neighbors, family members, etc. They try to fit in, to get along, to accommodate a community of interests in addition to their own. They practice the Golden Rule Do unto others as you would have them do unto you (reasonable variations notwithstanding).

As hams who comprise a federally licensed emergency service, we enjoy certain protections from *unreasonable* local restriction. These privileges are welcome and necessary as a whole, but they can be easily abused.

Just because we *can* transmit a 1500-W signal doesn't mean we *should*. Just because we *can* erect a 200-foot-high antenna tower doesn't mean we *should*. Hams who follow the Golden Rule *integrate* their radio pursuits with the pursuits of others—not because they *have* to, but because they *want* to!

Governments can't legislate common sense. That's up to us.

Okay, that's the end of my emotional pitch for restraint. If you're still tempted to reach for the power switch (the *high* power switch) or dig into your rainy day fund to purchase an amplifier, let's look at the facts.

The Ham Next Door

To start, let's assume that you have a typical shack. A 100-W transceiver graces your operating desk and "talks" to a coax-fed dipole (or two) through a 300-W antenna tuner. Thanks to the tuner, your rig can happily put out full power regardless of actual antenna/feed line SWRs on the various bands you work.

You use the same setup as your "Elmer" and most of the guys in the local radio club. Uncounted thousands of hams have used similar setups over the years, so they must work pretty well, right?

Maybe. But maybe not. In fact, you might have noticed that working stations on some bands doesn't seem as easy as it should—especially DX stations. You might even be dreaming of solving your problem by cranking up the power. By adding a gleaming, glowing monster amp to your modest shack, you might think, those stations with once-marginal copy will respond with ease.

It's a comforting image, but it's probably more fantasy than reality. Although you may not yet know it, you'll likely get a lot more signal for a lot less money if you upgrade your antenna system before shelling out the bucks for an amplifier.

The Price of Power

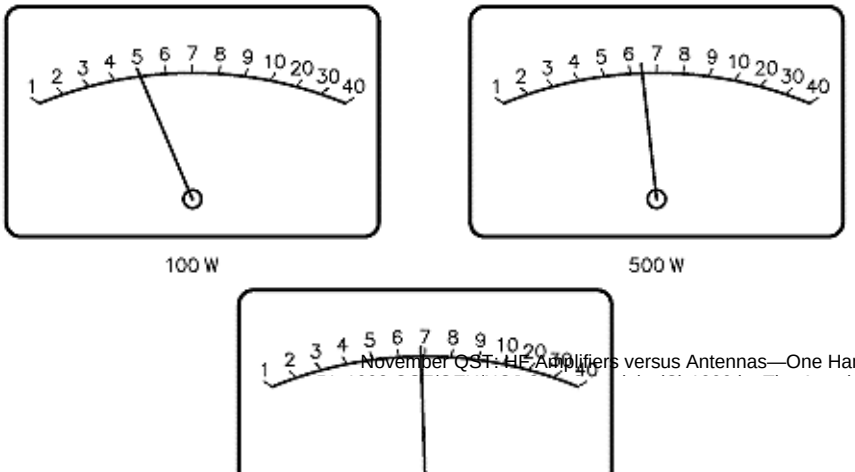
Let's boost our signal a step or two at a time and see how the decibels stack up against the greenbacks.

If your amplifier budget is modest, a small solid-state or single-tube amplifier will boost your 100-W barefoot signal to about 500 W. That's enough to be noticed, or so you think—but just how noticeable?

Here's the law every amplifier has to measure up to Every time you double your power output, stations that are receiving your signal hear a 3-dB increase in strength. That's *half* an S unit! To twitch the needle a full S unit you need to *quadruple* your power output (a 6-dB increase)!

The power output progression looks like this 100 W doubled to 200 W equals a 3-dB increase. Next, 200 W doubled to 400 W equals a 6-dB increase. Then, 400 W doubled to 800 W equals a 9-dB increase (exceeding the output power of our entry-level amplifier). Finally, 100 W times 10 equals 1000 W, a 10-dB increase in power output.

Our 500-W output amplifier gives us a smidgen more than a one S-unit boost on the other end (see **Figure 1**). That's not much—especially when you consider the cost.



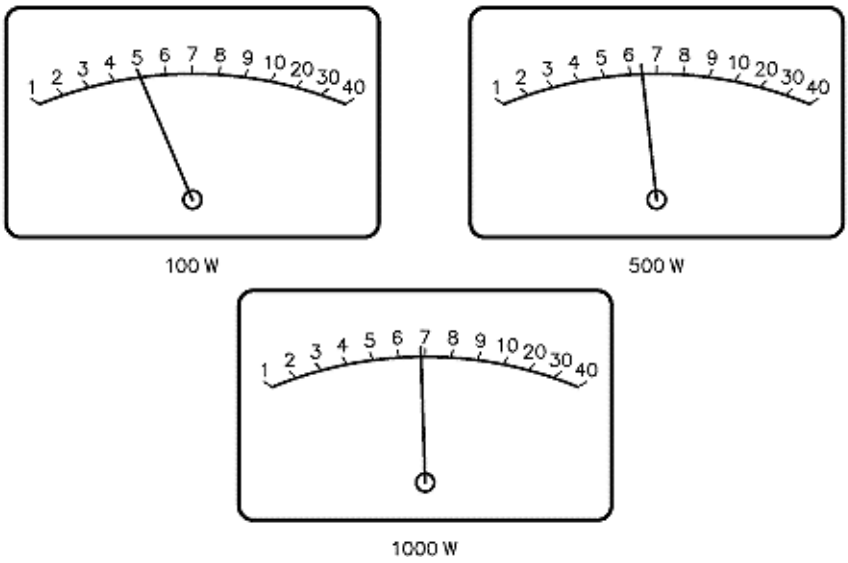


Figure 1—Spend a wad of cash on an RF power amplifier and what do you get? Let's assume that we have an average conversation in progress on a quiet band. Your current 100-W signal pushes an S meter on the receiving end to S5. Increase your output to 500 W and the other guy's meter might slide up to a tad more than S6—a change he won't even notice. Turn on the 1000-W afterburner and you'll make his meter twitch almost to S7. Oh boy! Yes, he'll probably notice a difference now, but he heard you well enough at S5, didn't he?

More Power

So, you want to run even more power? Using our calculations from before, boosting your signal to a kilowatt output provides a 10-dB shot in the arm. That's just under two S units on the other end—S3 to S5, S7 to S9, etc.

That's enough of a difference to be noticed, but still not enough to "burn down the barn." And by the way, the most affordable kilowatt amplifiers cost about $1500. If you really go for the gusto and buy a legal-limit amplifier, your 1500-W signal will be about 12 dB stronger than your "barefoot" transceiver. Because of the "price of power," 1500 W is still only two S units stronger! And a legal-limit amplifier is hardly a casual purchase. It'll set your wallet back about $2500.

Hidden Costs

Don't think you can get away with just an amplifier! The power output curve is often deceptive. For example, above 300 W output or so, you'll need a beefier antenna tuner. Expect to spend up to $500 for a good one.

And don't forget about the ac mains, either. You can probably get away with running a 500-W output amplifier on 120 V ac, but beyond that, it's 240 V all the way. (Don't believe me? A 500-W output amplifier runs about 1000 W input power. That's 8.5 A at 120 V. With your rig added in, that's more than 10 A. Believe me, the lights in your house will "jump" to the rhythm of your code key or your spoken words!)

Chances are good that you won't know how (or won't want) install that 240-V line yourself, either. The materials and an electrician to install them likely will total $300 to $500. Many first-time amplifier users don't consider their beast's power supply requirements until they've set up the amp and started "browning out" the rest of their house! If this is you, you'll be lucky if you don't trash your TV set or your home computer in the process of "modulating" your 120-V power feed!

If you live in an urban setting, don't neglect the potential "public relations" costs of firing up a killer signal in the midst of all those consumer electronics devices. I know...you can legally stand on the solid rock of FCC-mandated power output limits—but be warned that it can be a lonely vigil.

A Better Way?

To save wear and tear on your neighbors, fellow hams, your wallet and even your house wiring, consider improving your antenna system before investing in an amplifier. Here are some ideas to get you started

One almost universal way to get out more signal is to get your antenna(s) farther up in the air (your present antenna or a new

one). Build a taller mast, find a taller tree or put up a tower.

If that dipole just isn't cutting it, put up a contest-winning and DX-catching secret weapon a full-wave horizontal loop for 40 or 80 meters (up as high as possible, of course!). Feed it with coax and use a tuner on bands above the fundamental frequency. That's a "cheap 'n' dirty" way to snag an extra 2 to 10 dB, depending on frequency.

Disconnect the feed line from your coax-fed single-band dipole, the one you try to use on several bands, and replace it with 450-Ω ladder line (see **Figure 2**). With a coax feed, even though your antenna tuner may be presenting a happy impedance to your transmitter, feed line losses due to high SWR may slash your signal by 6, 10 or 25 dB, depending on the band and the size of your dipole! By using 450-Ω open-wire line you'll likely reclaim most of that lost power. Now that's a 6 to 20-dB shot in the arm that anyone can afford!

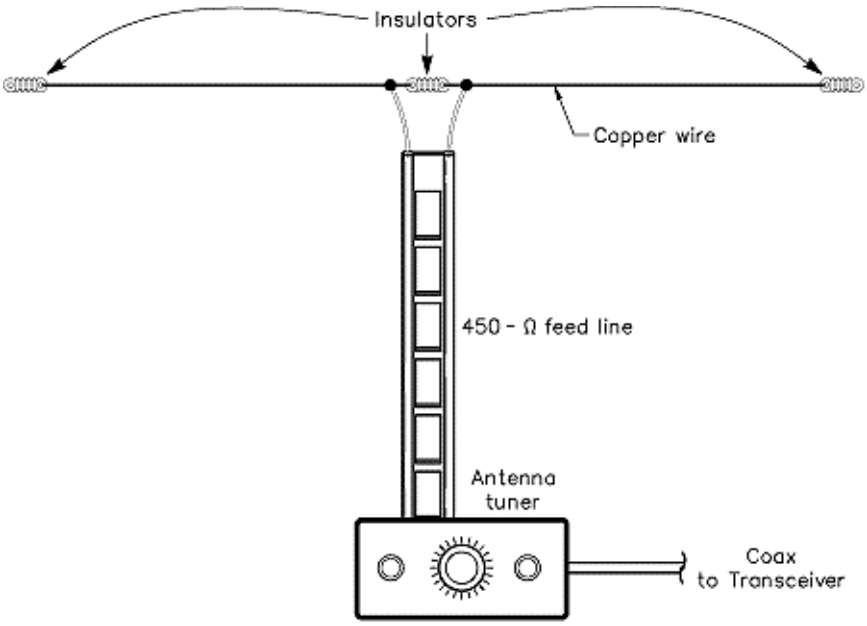


Figure 2—You can increase the performance of a simple dipole by using low-loss open-wire 450-Ω windowed feed line. This is one of the easiest, inexpensive antennas for the HF beginner. Just string up a dipole made of two equal lengths of copper wire. Don't worry about the overall length; just make it as long as you can. Connect the feed line to the center insulator and run it back to an antenna tuner with a balanced output. Attach coax between the tuner and the radio and you're in business on several bands!

For less than the price of an entry-level amplifier you can buy a multiband beam antenna and a decent rotator. This dynamic duo, mounted reasonably high, will offer a 5 to 7-dB steerable improvement to your signal. Remember Amplifiers only boost your transmitted signal and do *nothing* to improve reception. By rotating a directional antenna you can often achieve a double-whammy—boosting the signal you're trying to receive while attenuating signals that are unwanted. For example, if I'm working a European ham from my Minnesota QTH, a potentially interfering signal from an op in Florida—located in the side null of my directional antenna—may drop 25 dB or more! The difference, more than 30 dB of signal enhancement, could never be achieved by a lone amplifier.

On SSB, learn the *correct* use of your rig's speech processor. There's another 3-dB (or more) improvement, this time in the modulation department! No purchase necessary!

Aftermath

So, after looking at the cold, hard facts, do antennas win out over amplifiers at your shack? Or will your operating table soon be sporting some heavy iron? As always, the choice is yours.

Amplifiers do have their uses—especially *after* you've tweaked your antenna farm. Add a 10-dB amplifier to a 7-dB beam antenna and you've got a whopping 17-dB improvement in signal strength! That will put you on the map—especially when the minimum necessary power required to communicate calls for maximum smoke. And when conditions are poor an amp may make

the difference between being heard and being lost in the noise.

As long as it's confession time, let me come clean.... Most of my operating over the past 23 years has been at QRP or barefoot power levels, but I've used an amplifier every now and then.

The first was one that I built myself from scavenged parts. I was seduced by the possibility of a glowing 4-400A transmitting tube, and I was trying to work DX on 80 meters with a poor antenna.

The amplifier helped me put a few difficult QSOs in the log, but collateral considerations forced me to abandon my glowing metal and glass monstrosity. The 150-pound amp was collapsing my operating desk, and its draw from the 120-V mains was overwhelming! I could only use it in the wee hours when everyone else was in bed....

After I put up a decent 80-meter antenna, I never looked back. Given the choice, I'll take a "killer" antenna instead of a "rock crusher" any day! How about you?

S Meters and Radio Lore

Something needs to be said about S meters: With a few exceptions, they're inaccurate, nonlinear and of dubious calibration!

Each S unit on a typical S meter is supposed to indicate a 6-dB increase in the strength of a received signal. But it probably doesn't. Or it might—at one frequency on one band (or a few frequencies on a few bands). On other frequencies and modes, however, it might provide readings that are way out in left field.

S meters appeal to our senses and to our need to categorize and stratify things in our environment. They can be useful, but we shouldn't rely on them for precise measurements. That's what your brain is for. Use it and forget the bouncing needle!—*NT0Z*

When Less is More

Now that you've seen that it takes a whopping amount of extra power to make a noticeable difference in received signal strength, you might be wondering whether the cold equations work in the other direction—and they do!

If you have an okay signal with 100 W, you'll likely have a workable signal with 25 W, or even 5 W. That's the Holy Grail of QRP (low power) operation. The power output numbers work, just like before, in reverse.

Let's say that you have an S9 signal with 100 W output. Cutting your power to 50 W provides a 3-dB decrease in strength. Cutting power to 25 W adds another 3-dB reduction. Therefore, going from 100 W output to 25 W output has reduced your received signal strength by 6 dB—only 1 S unit! By drastically cutting your power output, your signal has dropped from S9 to S8! That's not a big deal!

Dropping from 100 W to 10 W is a 10-dB reduction—less than 2 S units. Dropping to 5 W, the commonly accepted threshold for QRP operation, totals 13 dB—just a smidgen more than 2 S units. Your signal will go from S9 to about S7! Again, not a big deal!

Add a decent directional gain antenna to the QRP equation and you're back in the old ballpark—while running a *lot* less power. That's QRP. And it's a lot of fun.—*NT0Z*