

RF Gain: Doing More with Less



Cranking your receiver gain to maximum is often unnecessary. In fact, it can make reception worse.

Steve Ford, WB8IMY

When I was gifted with my first HF receiver, I immediately noticed its prominent **RF GAIN** knob.

What a pointless control, I thought as I turned the knob to its full clockwise position. *Why would anyone set RF GAIN to anything less than maximum?*

It made perfect sense to me at the time. If I wanted to listen to weak signals, I needed every decibel of gain available. Gain controls should be set to full throttle, pedal to the metal, always. I was playing the role of guitarist Nigel Tufnel from the classic film parody *This is Spinal Tap*. My **RF GAIN** knob didn't stop at 10, it went to 11!

My next radio still featured the perplexing **RF GAIN** control and added a button marked **ATT** for attenuator. There was no way my fingers would ever touch *that* bit of plastic. The last thing I wanted to do was deliberately attenuate signals. How absurd.

Epiphany

The day of reckoning arrived when I tried my first HF contest. My poor transceiver — the brand will remain nameless — was swamped with signals. Rather than individual signals issuing from the speaker, what I heard was a blaring cacophony.

Against my better judgment, I decided that I had to stem the tide by the only means available — that useless **RF GAIN** control and the dreaded **ATT** button. I grimaced and slowly turned the knob counterclockwise. To my amazement, the chaos seemed to miraculously ease. Most of the signals were still there, but now I could pick them out individually.

After further thought, I realized that, by keeping the gain set to maximum, I was increasing signal strength, but also increasing noise and distortion. By reducing gain, the desired signals decreased in strength, but the noise appeared to diminish by a much greater degree. Some of the interfering signals seemed to vanish entirely.

I stabbed the **ATT** button, and down went the signals I wanted, along with the noise and the signals I *didn't* want. I tweaked the **RF GAIN** control clockwise until I reached a happy medium between the two. The contest environment was still challenging, but now it was much easier to navigate.

Powerful Foes

When you're trying to zero in on signals you want to hear, you are effectively at war with two powerful foes: noise — natural or manmade — and competing signals at nearby frequencies. Most of the nearby signals are generated by other stations, but some are generated *within your own radio*. More about this in a moment.

Filters, software or otherwise, can at least narrow the window of your receiver and prevent much of the garbage from getting through. However, your **RF GAIN** control and attenuator (if your radio has one) are still among

the most valuable tools at your disposal.

Think of the **ATT** button as a blunt instrument, and the **RF GAIN** control as a fine tool. The attenuator knocks down everything like a blow from a hammer, but by riding the **RF GAIN** control, you can finesse the experience and choose exactly the amount of gain that gives the best result.

Yes, the audio volume will drop. That's what **VOLUME** knobs are for. And yes, the S-meter will likely respond by suddenly rising to what appears to be a fixed level. Ignore it; you are only seeing an automatic gain control (AGC) response. S-meters are highly over-rated anyway.

Dealing with Noise

When it comes to noise, you'll find plenty on 2200 through 40 meters, particularly during spring and summer, when storms are marching across the landscape. But even in winter, you'll hear nature's noise as a constant sizzle across the bands.

To dig weak signals out of noise, you need to tip the signal-to-noise balance in favor of the signal. You can start by kicking in a level of attenuation. If your transceiver isn't blessed with this button, simply reduce your **RF gain**. The noise will diminish, and the weak signal you are trying to hear will likely become clearer.

Pushing Back on Big Signals

When dealing with heavy-duty signals on nearby frequencies, your strongest lines of defense are your filters, but your **RF GAIN** control has a major role to play as well. Powerful signals may create distortion products within your

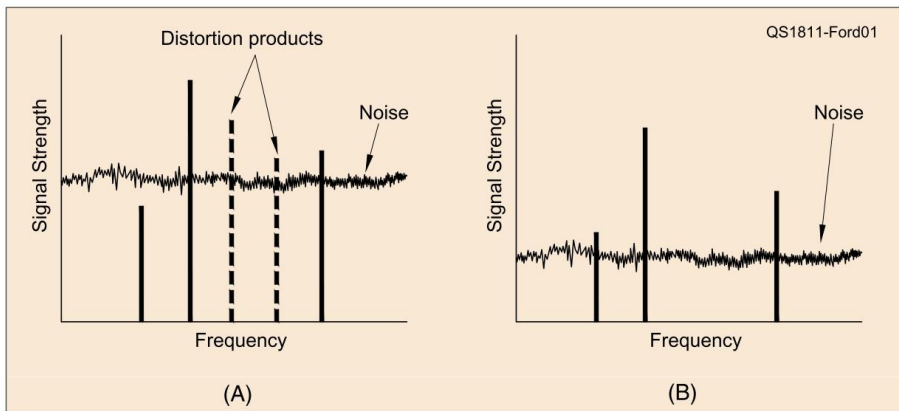


Figure 1 — At **A**, you see a typical situation where receiver gain is at maximum, raising both the received signals and the noise. You'll also see "ghost signals," distortion products created by overload. At **B**, gain has been reduced, lowering the noise and allowing the signals to be heard more clearly. Notice that the weaker signal on the left is now "above" the noise, and that the ghost signals have disappeared.

transceiver. These manifest as interfering "ghost signals." Ghostly as they may be, these distortion products can wreak havoc on your reception. Fortunately, you can banish the pesky phantoms by simply reducing your RF gain (see Figure 1).

By reducing gain, you'll hear a blessed reduction in noise and interference, and a simultaneous increase in signal clarity. As signal and noise levels fluctuate, keep riding the **RF GAIN** control, making small adjustments.

Resist the Preamp

If your transceiver has a switchable receive preamplifier, resist the urge to use it on any band below 17 meters. Preamplifiers are blunt instruments, too. They boost everything — signals and noise — and below 17 meters, they do far more harm than good.

The last thing you want to do on those bands is make the noise and interference even worse. Instead, rely on your **RF GAIN** control to separate the wheat from the chaff, and leave the preamplifier off.

Having said that, preamplifiers can still provide benefits to HF transceivers. On bands above 20 meters, a substantial portion of the noise you hear is generated by the circuits within your radio, rather than external sources. On those frequencies, giving

weak signals a preamplified kick may be helpful.

RF Gain and SDRs

I suspect we're approaching the time when traditional superheterodyne transceivers will yield their pedestals entirely to software-defined radios (SDRs). SDR technology is becoming more capable and affordable with every passing year, so its total dominance is almost inevitable.

Despite sophisticated SDR signal processing architecture, however, gain management is still highly important. SDRs work their magic by taking analog RF signals at the antenna input and sampling them at extremely high speeds through analog-to-digital converters, or ADCs. The ADC takes ultra-fast snapshots of signal characteristics and translates them to digital information.

Transceiver manufacturers design SDRs with filters and gain controls that stand ready to do their work before the signals reach the ADCs.

Further Reading

- "Receiver Sensitivity — Can You Have Too Much?" by Joel Hallas, W1ZR, in the June 2010 issue of *QST*.
- "Receiver Gain Control," by Joel Hallas, W1ZR, in the June 2006 issue of *QST*.

But hams being hams, we still tend to default to old habits and crank our SDR **RF GAIN** controls to "11," perhaps assuming the software deep within the radio will somehow compensate. That assumption is tragically mistaken.

Owning an SDR doesn't mean that you never need to touch the **RF GAIN** control or bring down the attenuator sledgehammer. On the contrary, by using these tools, you'll make your SDR listening experience even better than you might imagine.

Mind Games

Beyond improving receiver performance, I've found an interesting side effect of reducing my RF gain, especially during contests.

You see, I don't own an Amateur Radio mega-station. I don't have an antenna perched on a tower, or even on a rooftop. Instead, my primary antenna is a simple 102-foot wire dipole fed with windowed ladder line coupled to a remote antenna tuner. I'm unlikely to win any contests with this station, but I enjoy participating just for the pleasure of comparing my performance to prior competitions.

To keep my frustration level as low as possible, I employ the inverse of the "If You Can Hear Them, You Can Work Them" principle. That is, I deliberately switch in a significant amount of attenuation so that weak signals all but disappear.

This allows me to tune through the band without the annoyance of signal distortion and noise. But more importantly, it prevents me from beating my head against a wall trying to make contacts with stations that are unlikely to hear me. Am I using the attenuator to play mind games with myself? Probably, but in this instance, ignorance is definitely bliss.

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