# The Monitor

August 2007

## Message from the President

This past month saw the annual antenna issue of QST and this month's newsletter has a similar theme. It seems to me that the antenna systems are the most overlooked part of the typical ham station. Yes, I know we have many members with amazing antenna setups, but I would wager the average ham spends much less time and money on the antenna than on the radio.

In any case, read on and enjoy the wealth of information.

This month's club meeting will be on mobile operation with presentations from various members, including you if you like! See the description from AC1H in this newsletter.

See you at the club meeting!

73 de KX1Y
William Daugherty
TSRC President

### Upcoming Events

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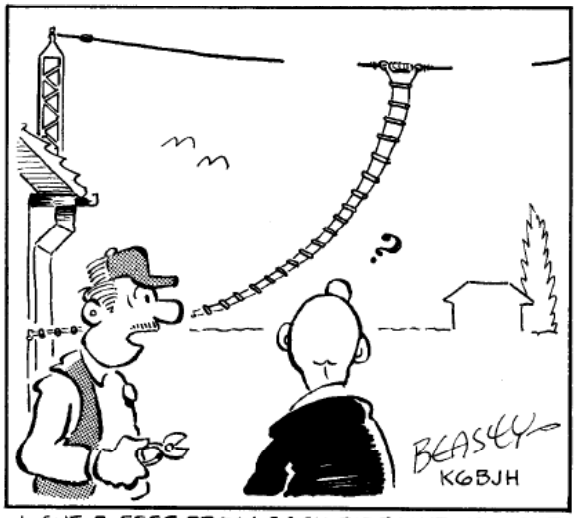
| TSRC Meeting | August 11, 2007, 9:00 am<br>EBA's, Hanover, NH |
| TSRC Meeting | September 8, 2007, 9:00 am<br>EBA's, Hanover, NH |




I CUT 2 FEET FROM EACH SIDE LIKE YOU SAID, BUT MY SWR WENT THROUGH THE ROOF!

## Much Ado about SWR, Watts and the Odd Decibel or Two

Dave Colter, WA1ZCN

I'm as guilty as anyone of attempting to squeeze an extra watt or two out of a transmitter, or trying to get an antenna's SWR as close to 1:1 as the laws of physics will allow. And I know, as you should too, that most of the time it just isn't worth the extra effort. Here's why.

To begin with, you need to know that you really can't hear any difference in a received signal with variations of less than1 dB. 3 dB is just about the threshold for most people to notice anything really useful, and we're not talking big changes here.

Let's assume a 100 watt HF transmitter for this example with a 100' run of good RG-8 coaxial feed line and an antenna tuner set to null. With a 1:1 SWR measured at the transmitter, there is still some reflected power – no antenna is perfect. It's only about a quarter of a watt though, a loss of radiated power amounting to one hundredth of a dB. The feed line loss absorbs the tiny reflected signal, so it doesn't register on the meter. Even the most fanatical watt-chaser wouldn't bother with that!

At 1.5:1, the reflected power is 4.00 watts, for a net loss of 0.177 dB. Still no problem, right? Most of us are quite happy with that SWR.

With a 2:1 SWR, the reflected power is up to a whopping 11.10 watts. That's more than 10% of your

forward power! But, that's only a tiny 0.510 dB. The other station still can't hear the difference.

Most folks consider 3:1 to be the threshold of "really bad" SWR. With 25 watts of power being reflected, the other guy is sure to notice a weaker signal, right? Not likely. It still only amounts to a barely audible 1.249 dB loss.

To get all the way to 3dB of loss, you would need a reflected power of 50 watts. That's right – an off-the scale 40:1 SWR reading and 50% of your power coming back down the coax! And what difference will that make at the receiving end? One half of an S-unit, a barely audible change. However, there may be other reasons for concern with SWR levels of this magnitude. We'll get to that in a moment.

WA1ZCN paying our rent at the W1FN repeater site

Now, where does all that reflected power go? Well, when it gets back to the antenna tuner, it bounces up to the antenna again, and some of it gets radiated. The signal ping-pongs back and forth (at near light speed) with a portion radiated each time it reaches the antenna. (With no tuner and a transmitter with a good 50 ohm match, the entire reflected signal would be absorbed and lost on the first bounce.) This complex behavior is what your SWR meter indicates. With low-loss open wire feed line (also known as ladder line), most of the signal will eventually be radiated. In higher loss coax, much of the reflected signal will be absorbed and wasted as heat. This is why the SWR losses can actually be worse with smaller coax sizes, and why the reflected power is always higher when measured at the antenna end of the coax – sometimes significantly so. With a 4.5dB cable loss, an SWR of 2:1 at the transmitter would be 20:1 at the antenna! With lossy cable runs, it's important to measure the SWR at the antenna.

"Wait" you say, "what about my antenna tuner? Won't that fix everything?" Well, first of all, antenna tuners don't really tune the antenna. You can only tune an antenna by altering the antenna itself. What we call antenna tuners are really resonators and impedance transformers that fool the transmitter into thinking everything is okay, in effect "hiding" the problem. That's why many hams prefer to call them trans-matches. While using a tuner with open wire line will work well, trying to hide a very high SWR on a coax-fed antenna can result in much reduced performance.

When should you worry about your SWR? If you're using low-loss ladder line and a tuner to feed your HF antenna, don't bother. Even with an SWR of 1000:1, most of the reflected power will eventually be radiated by the antenna. It would take an unlikely SWR of several thousand to one to create efficiency problems. Rather than play with the antenna, adjust your tuner for something close to 1:1 at the radio and forget it.

However, if you are using coax and have a very high SWR, especially with lossy sizes like RG-58, or very long runs of any coax, the feed line losses can quickly eat up your signal and may cause your sensitive no-tune transmitter to shut down. In this case, it's time to adjust the antenna itself.

As a rule of thumb, as long as you have decent low-loss coax with runs shorter than 100', don't worry about an SWR of 3:1 or less. With good quality coax or very short runs, even an SWR of 5:1 shouldn't noticeably affect performance or cause problems. Another way to look at it – if you want to use a small diameter or long coaxial feed line, make sure your antenna is resonant and very close to a 50 ohm load. Otherwise, go for a bigger "pipe."

The one overall exception is for HF power levels greater than 500 watts, regardless of transmission line type, where the SWR should be kept as low as possible to avoid amplifier, antenna tuner, or filter damage. The only solution is to make sure your antenna is as close to a resonant 50 ohm load as possible.

On VHF, an SWR of 2:1 or more should be corrected by adjusting the antenna, as coax losses at higher frequencies will quickly eat up your power. The higher the frequency, the more critical SWR becomes, and the less you can tolerate. Antenna tuners at VHF and higher frequencies only hide the problem from your SWR meter and transmitter, so don't bother using them. The absorption is so great that performance will still suffer significantly.

Beyond SWR

Considering buying a linear? With RF amplifiers, the only power change that even begins to make a useful difference at the receiving end is doubling it, a +3dB change. To make a really significant difference you would need to double your power twice – from 100 to 400 watts, or from 400 to 1600 watts, a +6dB change. This is one reason that legal-limit amplifiers are so popular with serious contesters. For many, "halfway measures" don't make enough difference to be worth the money and effort.

The same is true of antennas. Doubling the size of your array amounts to a 3 dB change. To get another 3 dB of gain, you would need to double it yet again. The good news is that unlike transmitter power gains, antenna gain works for both transmit and receive. (The bad news is that large increases in antenna gain also result in very narrow beam widths that require more precise aiming.)

## What Exactly is SWR?

Put simply, SWR (more correctly, VSWR or Voltage Standing Wave Ratio) is a measurement of the amount of RF voltage from the transmitter that is not getting from the coax into the antenna. VSWR is a measure of the ratio of the wave on the transmission line traveling toward the load, to the wave traveling away from the load. With waves traveling in both directions, a "standing wave" is created on the transmission line. The voltages of both signals add together at certain points and subtract from each other a quarter wavelength away. The ratio of these two voltages is the VSWR. An SWR meter measures the power going toward the antenna and the reflected power coming back down from the antenna. From this information the VSWR can be calculated, rather than having to slide a voltmeter down the line to find and measure the maximum and minimum values.

Dave McGaw
N1HAC

Now I hope you can see why chasing a small percentage of forward or reflected power on usually makes no difference in the real world. Remember all this when you choose your next rig, or work on an antenna. Big changes can help at least a little – little changes aren't worth the money or effort.

References:
SWR loss calculations - Kurt N. Sturba – Worldradio Dec. 1988.
The SWR Obsession – Steve Ford WB8IMY, QST April 1994
Understanding SWR by Example – Darren Walraven K5DVW, QST November 2006
Beasley Cartoon courtesy of QST, April 1994.

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Don't forget to check the TSRC Home Page!
Make it your default start page!
http://www.w1fn.org

The program for this month's meeting is Mobile Operation. Thanks to everyone who responded to the email questionnaire. Those who didn't get a chance to respond by email will have a chance to give their input at the meeting because there is no 'presenter' for this program. Rather the meeting will be an open forum where everyone can share their mobile operation 'war stories.' Also, the questionnaire did surface a few topics that should make for interesting discussions. Then we will adjourn to the streets outside EBA's to check out the moible installations of fellow club members, so if you do operate mobile please bring your equipped vehicle to the meeting -- or actually have it bring you to the meeting.

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Club email reflector:
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*Here's the current setup on Moose Mtn. 2m on the right and 440 inverted.*

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