SWR: a Poor Design Metric

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We've all heard it from countless hams: "My vertical is less than 1.5:1 across the entire band!" But what does this really mean? As it turns out, it doesn't mean much!

SWR, short for Standing Wave Ratio, essentially measures the match between your transmitter and your antenna. It does not mean the antenna is radiating well, or even radiating at all. You don't have to take my word for it, of course; you can do an experiment on your own.

Imagine using a coat hanger as an antenna for 160m. Obviously, a coat hanger is far too small to be an effective radiator on topband, but imagine you have endless vacuum variable capacitors and a box of high-voltage coils at your disposal. You could certainly construct a matching network that would present a 50 Ohm load to your transmitter and return better than 1.5:1 at least *somewhere* in the band. You might even increase the SWR bandwidth by using a heavier gauge coat hanger.

Armed with your new coat hanger antenna mounted five feet above your garden, you might spend every night on topband pounding brass until your finals glow cherry red. You'll be hard pressed to make a single QSO, although, in all fairness, it *has* been done. You might ask "Why does this antenna stink? It's less than 1.5:1 with no tuner!"

There's more to antennas than their interaction with your radio. Model your coat hanger and you'll find it has terrible gain and an awfully high primary lobe -- especially at five feet above your garden. Now we're starting to see why that pretty SWR is pretty meaningless!

The use of SWR to measure one's antenna seems to be amplified with vertical and inverted-L antennas, where misinformation has been allowed to propagate the annals of the hobby for almost a century. Consider the inverted-L, for instance: just today, I found several websites claiming that you only need a ¼-wave long radiating wire and a single ¼-wave radial. This could very well present 2:1 or better at your transmitter -- the websites are correct. But it's only presenting an acceptable SWR because the majority of the power has been lost to the ground at the feedpoint!

Designing antennas strictly for resonance has one key advantage: ease. We want to believe that we can cut a quarter wave vertical and a single quarter wave radial and be on the air making QSOs right away. That's simply not the case; we need to consider matching the radiator separately. In the case of our inverted-L or other similar vertical, we might make the radiator a bit longer, understanding that we'll need to build a matching circuit but that the antenna itself will work better with the voltage maximum higher up in the vertical.

How do we get away with simple half wave dipoles, where each leg is the aforementioned single quarter wave wire? Because they're generally high enough in the air to avoid ground losses at the feedpoint. In other words, the SWR *usually* accurately reflects the radiation efficiency. But if we apply that thought to other antennas, like end-fed wires, verticals, multi-band designs, etc., we see that it is a myth. I suspect the popularity of the simple half wave dipole has helped to continues this myth.

The moral of the story here is to design the antenna first. Model it. Pay no mind to the matching until you have produced a satisfactory design. Then, build a cheap and easy matching network to keep your transmitter happy.