A New Antenna Model (Jul/Aug 2012)

Dear Glenn,

Your "New Antenna Model" was an interesting article. Thanks for sharing your ideas, but I do have a question.

Is Figure 4D (all the way down) on page 10 (SWR and Return Loss), is the vertical axis correct? I think RL is defined as: RL = –20 log SWR + 1 / SWR – 1

Therefore,

SWR 2 = 9.5 dB RL;

SWR 1.2 = 20.8 dB RL,

SWR 3 = 6 dB RL,

SWR 6 = 2.9 dB RL and so on.

So it appears to me to be somehow shifted on the right vertical axis.

On the left axis, SWR should not start at SWR = 0 but SWR = 1.

Or am I missing something?

— 73, Andy Hansen, HB9CVQ (DK2VQ, AK4IG), Switzerland; **hb9cvq@hispeed.ch**

Dear Andy,

No, you're not missing something, it's wrong. Thanks for the catch!

It's also correct to state RL as (1 + ρ) / (1 – ρ) where ρ is the reflection coefficient.This gives the same numbers as your equation, so ρ = 0.5 means a voltage reflection coefficient of 0.5, which is an SWR of (1 + 0.5) / (1 – 0.5) = 3 and a return loss = –20 log(0.5) = 6 dB.

During graphics layout for publication in *QEX* the left axis got re-labeled. As published, Figure 4D has an SWR less than unity shown at the bottom of the left axis and some of the data seems to go down there! If we can perfect this, it might be useful for negative noise figure receivers! In fact, the axis should have been labeled 1 to 10 rather than 0 to 10 as published.

Some labeling corrections on Figure 8 also didn't make it into the published version. Part A should indicate that image is for a ½ λ dipole, B is a 1λ dipole, C is a 3/2λ dipole and D is a 2λ dipole. I've put a couple of these corrections up on my website at **www.sonic.net/~n6gn**. If you find other problems, please let me know and I'll try to correct them there.

— 73, Glenn Elmore, N6GN, 446 Halter Ct, Santa Rosa, CA 95401; **n6gn@sonic.net**

Hi Larry,

The article "A New Antenna Model" by Glenn Elmore, N6GN, in the Jul/ Aug 2012 issue of *QEX* was very interesting and thought provoking, however, there is one aspect with which I would like to take issue. It is his statement that "power is coupled into the radiating tip where the radiation resistance is located." I am not sure whether he really believes this or whether it is a merely a statement of the way his *model* portrays the operation. Any way, it is totally untrue for a real antenna that radiation takes place at the tip, but unfortunately his statement has been taken at face value in at least one antenna forum on the Internet. I would therefore like to set the record straight.

There is one basic fact we know about radiation and it was summed up by the famous theoretical physicist, Richard Feynman, when he said “If you wiggle an electron, other electrons around it feel a force.” So the basis of radiation is that we need to accelerate electrons, or more generally charged bodies. Notice that simply moving the electron at a constant velocity is not sufficient for radiation, as we know since direct current does not radiate.

We normally produce radiation by accelerating charges in a *conductor*, but in principle we do not *need* a conductor. For instance if we have a charged body and swing it around on the end of an insulator (a piece of string) then this will radiate. In practice such an experiment would be difficult to do because we cannot rotate the charge very fast and so an extremely large charge would be necessary to produce any measureable radiation. But the principle stands, that radiation merely needs the acceleration of charges or electrons.

Turning now to antennas, *these are merely devices for accelerating charge.* Conductors are very handy here because they have a lot of free electrons, which move through the conductor with relative ease and so are easily accelerated. Glenn Elmore’s article correctly points out that the ends of wire antennas have a very high voltage. Of course that is *exactly* what is needed to accelerate the electrons, and why a normal antenna configuration is so good at doing this. The high voltage does not radiate, however, it is the accelerated electrons that radiate, and these are in the high current part of the antenna (since a current *is* the movement of electrons).

It is worth a comment at this point on fields. No one knows *how* an accelerating electron produces a force on another, and so we have invented fields to help us explain what is happening. We cannot prove that these fields exist, however. We might try to measure them, and for this we take a small conducting dipole or loop and move it around the radiating antenna and measure a voltage. But the voltage is a result of the force on the electrons in our measurement loop, and proves only what we knew already that “if you wiggle an electron, other electrons around it feel a force.” It does not prove that there are fields. Unfortunately, some workers have taken the field concept to outlandish lengths, as evidenced by the “cross field” antenna, and if we analyze this to find where in the antenna it is accelerating electrons, it is evident that it will not work, at least not in the way the authors claim.

So remember, when you put up a small wire antenna in the garden and accelerate its free electrons with a few watts of power, the electrons in another antenna 1000 miles away will feel a force, which the receiver at that end can detect. Who would have believed that this would be possible? I have been involved in electromagnetics all my adult life and I still think it is magic!

— 73,Alan Payne G3RBJ; **paynealpayne@aol.com.**

Hi Alan,

Thanks so much for writing. I'm pleased that this model is prompting questions. You ask some good ones.

Richard Feynman does describe acceleration of an electron as producing a force on other charges as a fundamental principle and that this occurs whether the charge is in a conductor or not. He also posits as similarly fundamental, however, the theory of superposition. (Richard Feynman, *Lectures on Physics*, Vol. I, 12-9). It is truly an amazing thing that we can accelerate charges with our amateur radio transmitters and see the effects at great distance. It is also amazing that the effects from multiple electric charges, whether static, moving steadily or accelerating, can be added together without any consideration of interaction among them to obtain the result predicted by field theory.

As a result of superposition, mere acceleration of a charge does not mandate radiation *in the far field.* Far field effects are described by the sum of the effects from all charges and these may add to zero. It is for this reason that ideal transmission lines can be understood not to radiate. In operation, coaxial cable or balanced line, for example, each have accelerating charges which can produce force on other charges. Superposition allows that the effects of all charges must be considered, however, in determining the effect on a distant (test) charge as modelled by field theory. For ideal transmission lines, the effects of the moving charges in the two different conductors cancel, such that the total effect can and does sum to zero. Thus, they do not radiate even though individual charges are being accelerated within them.

The same is true for the model I have presented. It describes an antenna element as a surface wave transmission line having axial and longitudinal symmetry in regions far from the center and ends. The net far-field force produced by all of the accelerating charges is zero. Only from regions where there is asymmetry is there any net far-field effect (radiation) produced. As intense as they may be in the high current regions along the SWTL, the axial and longitudinal fields are symmetric — each field “line” has an “opposite twin” that cancels its effect in the far field.

With regard to a model and our beliefs, I'd like to point back to the statement in the article, “All models are wrong, but some are useful.” If we ever believe that we comprehend the final, precise and complete answer — if we even believe that such might be attainable — I think we limit ourselves. Models are useful and their utility can be seen in the ways they allow us to expand our understanding, extend our applications and enjoy the world we see around us. The model I have presented portrays antennas as wave devices in a manner that fits what we measure and currently understand. Whether we use field theory, theory of potentials, QED or something else, I hope that our exploration of antennas and our enjoyment of the magic of Amateur Radio will never be limited by “is” but will have the freedom of “acts like.” It's truly wonderful that there is always more for us to discover!

— 73, Glenn Elmore, N6GN; **n6gn@sonic.net**