Ham 71 – Antenna, the basics

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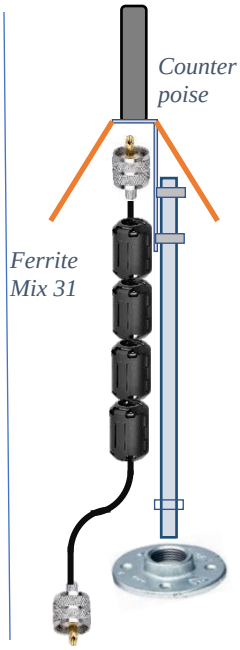

1. The teacher in me says KISS. The mathematician in me says equations are the simplest way to explain. My artist colleague says no! So, we will compromise with mostly no. An equation will be a pictorial to see how things fit together, but we will not do any calculations.
2. An antenna network consists of a radiator, a return path (counterpoise), and a feedline (coax).
3. Impedance is the properties of the way wires are made, connected, and arranged. It causes opposition to flow. Measure impedance components with the unit of Ohms, Ω.
   a. Wire resistance, R_W, is like friction wasted as heat loss. Radiation resistance, R_x, converts transmitted energy into the air. Wire that is bent or coiled is magnetic called inductive reactance, X_L. Wire next to another stores electric charge called capacitive reactance, X_C.
   b. Resistances adds together, reactance subtracts. We use the letter 'j' to show reactances act perpendicular to wire resistance. It is kind of perpendicular looking..
   c. Let's make a pictorial diagram with these letters. See how easy that is.
      $Z = (R_W + R_x) + j\,(X_L - X_C)$
4. Our objective for the antenna is maximum radiation, on a chosen frequency, with minimum heat.
   a. Loss: Make R_W as low as possible to minimize heat. Large diameter reduces R_W.
   b. Tune: Make $X_L = X_C$, called resonance, to tune the antenna to the proper frequency.
   c. Match: If we do those, $Z = R_x$. Make Z match the characteristic impedance of the coax, 50 Ω.
5. Visually, we can look at the letter picture and see how everything fits together.
6. To build or improve the antenna, an antenna analyzer of some type is very important.
   a. Start with one part, then work from there. This process is necessary for HF, but we will use VHF because of smaller numbers.
   b. A ¼ wavelength, λ/4, VHF antenna is 20" long. Vary length of counterpoise radial to adjust X. Too long makes X_L dominate, too short makes X_C dominate. λ/4 makes them equal, so X = 0, but resistance is only 23 Ohms.
   c. Shorten radials to take less space. X and SWR change little until λ/12. A bonus is radiation resistance increase to match.
   d. If radials are short, increase radiator length to λ/3 for resonance and match. Radial length varies inversely with radial length.
   e. Give radial a down angle of 45^0 to improve match, gain, and SWR. X is unchanged with angle.
   f. Use even number of radials so current balances. Two is adequate. More than 4 is not productive.
   g. To increase inductance add a coil. Inductance is 0.07 μH / λ-meter, i.e 20-meter = 1.4 μH
7. Life is good. Enjoy!