Outline For HCARS June 13, 2022

Simple Wire Antennas

1. Introduction
   1. For this discussion I am dividing wire antennas into two categories
      1. Resonate
      2. Non-resonate
   2. I plan to keep the math to a minimum but discuss a couple of concepts that help the understanding of how the types of wire antennas I will discuss work.
   3. I will be approaching this subject from the viewpoint of modern solid-state transceivers.
2. History
   1. Early tube-type transmitters were more forgiving of mis-matched antennas.
   2. Many amateurs used a tuner with large air gap capacitors and tapped inductors to match the impedance of the transmitter to the antenna.
      1. Often the antenna was a random length of wire that connected directly to the tuner.
      2. The old tuners could match a wide range of impedances to the 50-ohm output of the transmitter.
      3. Many if not most amateurs built their own tuner
         1. Thus, a brag was often “my tuner can load a one-eyed tom cat hanging on the screen door.”
   3. Nowadays we are using transceivers that have built in tuners.
      1. They are super convenient but
      2. Typically, are limited to tuning a 3 to 1 SWR or less.
      3. This limitation causes us to find ways to make our wire antennas compatible with current equipment.
3. Resonate antennas
   1. I am going to limit my discussion to half wave antennas and multiples thereof.
   2. Understanding of how RF current and voltage divide in a half wave antenna helps understand why feed point impedance changes based on the location of the feed point.
      1. Show chart voltage high at the ends, current high at the midpoint
      2. Ohm’s law: E=IR
         1. Since no antenna is purely resistive, we can substitute impedance (Z) for R. Therefore, E=IZ
         2. Solving for Z; Z=E/I
      3. At the center of the antenna the impedance will be small whereas at the ends it is very high.
         1. Typically, the dipoles fed at the center will have an impedance between 30 and 70 ohms.
         2. Dipoles fed at the end will have impedances running 2000 to 5000 ohms.
   3. Center-fed dipole
      1. Matches well with 50 ohm coax
      2. Simple to make
      3. Low cost
      4. Requires three points of attachment
      5. Direct connection to 50-ohm coax works well.
      6. A 1:1 balun can be used successfully.
      7. Typically a single band antenna but will also work on the third harmonic of the band it is cut for. (e.g. 7 Mhz and 21 Mhz)
      8. Length is determined by 468/ frequency in megahertz for flat construction. An inverted V will be 2% to 5% shorter.
   4. Off-center fed dipole
      1. Requires 4:1 balun to match 50-ohm coax
      2. Simple to make, but requires more measuring
      3. Low cost, but does require an additional piece of hardware
      4. Requires three points of attachment
      5. Length is determined by 468/ frequency in megahertz
      6. The feed point is determined by 64% of the total length (roughly 2/3 point)
      7. Covers the band it is cut for plus even harmonics thereof. (e.g. 80, 40, 20 & 10 meters)
      8. When trimming make sure to use the 64/36 ratio
      9. Palomar Engineers has a slightly different design with a gimmick to cover more bands
   5. End-fed dipole (EFHW)
      1. Requires a 49:1 unun to match 50-ohm coax
         1. Some writers advocate a 64:1 unun for best match
         2. My inverted L configuration required a 25:1 unun for best match
      2. Simple to make
      3. Low cost - similar to off-center fed dipole
      4. Requires only two points of attachment
      5. Length for lowest band calculated by 468/ frequency in megahertz
      6. Can be used in many configurations successfully
      7. Some writers recommend a counterpoise, but I just attached the ground terminal to my tower ground
      8. Multiband antenna (show my chart)
         1. Mine covers the high end of 80, all of 40, 30, 20, 15, 12, 10
         2. Internal tuner needed on 80 and 15
         3. External tuner can easily match 17
      9. Antenna analyzer very helpful in optimizing the antenna
4. Non-Resonate Antennas
   1. Random length wire antennas is a misnomer.
   2. Cannot be a half wave on any frequency you want to use
      1. Refer to impedance along a ½ wave antenna
      2. Show table for lengths to avoid <https://www.hamuniverse.com/randomwireantennalengths.html>

<https://udel.edu/~mm/ham/randomWire/>

* + 1. Show optimum lengths
  1. Wire length should be at least ¼ wave length for the lowest band you want to use.
     1. For 1.9 MHz ¼ wave length is 123’
     2. If you want to work all the HF bands, including 160 the nearest non-resonate wire length is 148’
  2. A non-resonate wire length a 9:1 unun should put impedance within range of the built-in tuners.

1. Note on Baluns and Ununs
   1. Easy DIY project
   2. Core material is critical for broad band response
      1. Mix 43 is optimum for HF operation
      2. Examples: FT-240-43, FT-140-43
   3. Demonstrate testing the response of toroid