Antenna Overview

ERC Storehouse Net Online Training
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Mention that just because there is no power doesn't mean there is no net.

Introduction

Welcome to tonight's training. I want to talk a little about antennas. Antennas are every bit an art as they are a science. The theory can get very complex and a complete training on antennas could go on for days, even weeks…maybe years.

We'll be keeping it simple tonight. And to further simplify it, we'll limit our discussion to VHF/UHF systems and save an HF discussion for another time.

After a brief history, I'd like to cover some very basic terms and theory. Then I'll briefly mention three types of antennas. Finally, I'll wrap things up with a brief explanation of j-poles and slim-jim antennas.

History

In the 1890s, there were only a few antennas in the world. These rudimentary devices were primarly a part of experiments that demonstrated the transmission of electromagnetic waves. By World War II, antennas had become so ubiquitous that their use had transformed the lives of the average person via radio and television reception. The number of antennas in the United States was on the order of one per household, representing growth rivaling the auto industry during the same period.

By the early 21st century, thanks in large part to mobile phones, the average person now carries one or more antennas on them wherever they go (cell phones can have multiple antennas, if GPS is used, for instance). This significant rate of growth is not likely to slow, as wireless communication systems become a larger part of everyday life. In addition, the strong growth in RFID devices suggests that the number of antennas in use may increase to one antenna per object in the world (product, container, pet, banana, toy, cd, etc.). This number would dwarf the number of antennas in use today.[1]

Terms & Theory

Wavelength

The distance between one peak of a wave and the next peak. It is equal to the speed of the wave divided by its frequency. All electromagnetic waves travel at the speed of light, 300 million meters per second. Therefore, 300 divided by the frequency in megahertz equals the wavelength in meters. To find the length in feet, use 990 divided by the frequency in megahertz.

[1] http://www.antenna-theory.com/intro/main.php

Resonance
A radio and antenna system is said to be resonant if the impedance of the radio and the impedance of the antenna match. Nearly all amateur radios have a 50 ohm impedance where the coax or antenna connects to the radio. But the impedance of the antenna will vary with the type of antenna, the configuration of the antenna, and the frequency of the wave.

Bandwidth
Bandwidth is the difference between the upper and lower frequencies in a continuous set of frequencies.[2] In our world, it can also refer to the amount of spectrum that a signal consumes. For example, a typical FM transmission on VHF or UHF consumes about 15 kHz of spectrum or it has a bandwidth of about 15 kHz. A morse code signal has a bandwidth of about 300 hertz.

Basic Antenna Types

Three basic types: dipole, vertical, directional

http://www.packetradio.com/ant.htm

Dipole
The dipole antenna, sometimes called a doublet, is simplest and perhaps one of the most commonly used class of antenna. In general, it consists of two symmetrical radiating elements. Some of you may be familiar with the old TV rabbit ear antennas. These are a prime example of a dipole. Typically, one side (or element) of the dipole is connected to the center conductor of the coax and the other side is connected to the shield.

The most common type of dipole is a half-wave dipole. It is physically one-half of a wavelength long from one end to the other. In other words, each side of the dipole is a quarter wavelength long. If I am constructing a half-wave dipole for 146 Mhz, the center of the 2 meter band, what is the total length of my antenna, end to end. A half-wave dipole resonant at 146 MHz; what is the length in meters?

Please give your call sign and wait to be acknowledged before giving your answer. (1.03 meters)

300 divided by the frequency in MHz (146) gives us the 2.06 meters which is a full wavelength. We need to divide the number in half to get the length of a half-wave dipole. Therefore, 1.03 meters.

Now it might surprise you to learn that most dipoles will not be resonant at the calculated length. This is where the art of antenna theory comes into play. Because of the properties of a half-wave dipole, the calculated length is often too long and should generally be shortened by about 1% of the overall length.

Practices teaches us that you purposely cut your antenna a little LONG, raise it to where it will be permanently mounted, and then check what frequency it is resonant at. If the measured frequency is too low, then trim a short amount from each side of the antenna and measure again. If the measured frequency is too high, then your antenna is too short and you'll need to add additional length by soldering or securely attaching more wire to each end to make it longer.

[2] https://en.wikipedia.org/wiki/Bandwidth_%28signal_processing%29

Although dipoles generally radiate broadside to the antenna, they are often considered omni-directional.

Directional

Directional antennas are designed to focus the bulk of the signal (both transmit and receive) in one direction. The simplest beam antennas are called yagis and operate on the same basic principles as a dipole. A Yagi antenna has feed line connected to a driven element, one piece of the feed line to each side of the element. A one or more reflectors are placed behind the driven element. The reflectors have no electrical or physical connection to the driven element and are slightly longer in size. One or more director elements, also with no electrical connection to the driven element, are placed in "front". These are usually slightly shorter in length with respect to the driven element. The exact length of each of the elements and the distance between the elements matters. Calculators can be found abundantly online to generate exact specifications based on the desired frequency.

Vertical

Vertical antennas can be thought of as half of a dipole antenna standing on end. Think of the mag-mount antenna on your car or the antenna on your handheld radio. These work best when attached to some kind of ground plane like the roof of your car, a filing cabinet or a music stand. Radials, or wires laying on or in the ground, extending out from the base of the antenna can also be used. The metal on the roof of your car or the radials on the ground act as the other half of the dipole antenna. Vertical antennas are omni-directional, meaning they radiate equally in all directions.

J-pole

I want to briefly mention two other types of antennas, the J-Pole and the Slim-Jim.

The J-pole consists of a half-wavelength radiator with a quarter-wavelength parallel matching stub. It gets its name from the resulting shape that resembles the letter J. Although, in some respects, the j-pole looks like and behaves like a vertical antenna, it does not require a ground plane. They are easy to construct and perform very well.

Slim-Jim

Some people will interchange or even confuse a j-pole with a slim-JIM antenna. The construction of a slim-JIM is similar to a J-Pole, but technically the slim-JIM more closely mimics a folded dipole in which the ends of the dipole are folded back on itself forming a narrow loop. The slim-JIM gets its name from the J-type matching stub. "JIM" is actually an acronym that stands for "J Integrated Matching".

You may have also heard them referred to as a roll-up j-pole. When a slim-JIM is constructed from 300 ohm feed line – the flat lead type used to feed television antennas – it becomes a very portable and flexible antenna that can easily be "rolled up" and thrown into a go bag.

I know that I've just scratched the surface of antennas tonight and I've probably left many you pulling your hair out longing for more details. I believe the Rigby Region is talking antennas at their monthly

training meeting next week on July 16. That would be a great opportunity to glean some more information.

That concludes tonight's training. This is N7TMS back to net control.