

The Dipole Antenna

My favorite type of antenna

The dipole antenna is the most widely used type of antenna for high frequencies and in physics theory, is the simplest form of antenna. A one-half wavelength dipole antenna commonly consists of two quarter-wavelength pieces of copper wire, called "legs", placed end-to-end, then trimmed to the resonant center frequency of the desired band. The feed line shield and center conductors are then connected to a leg.

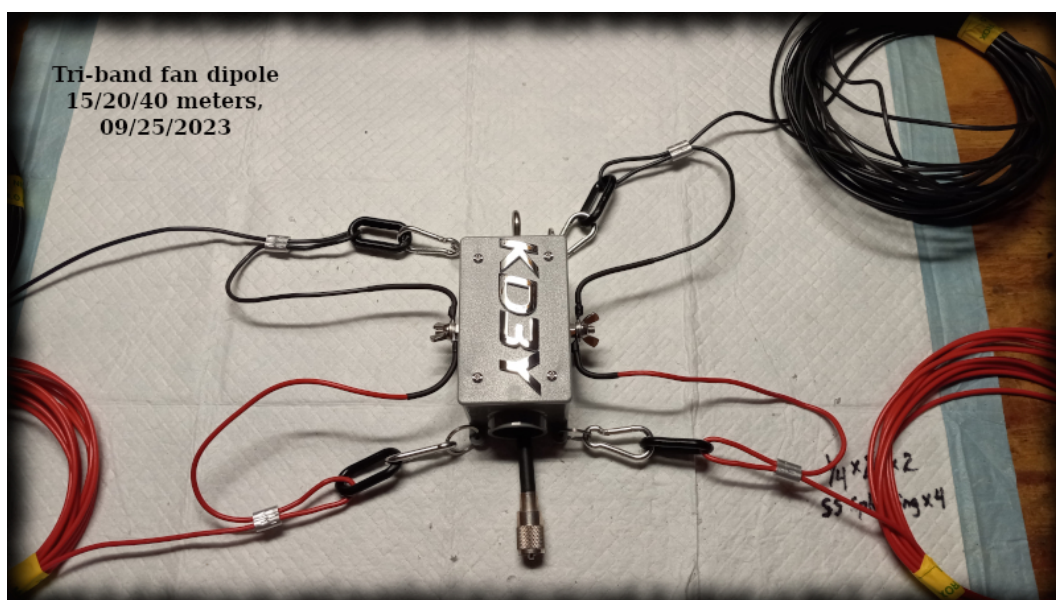
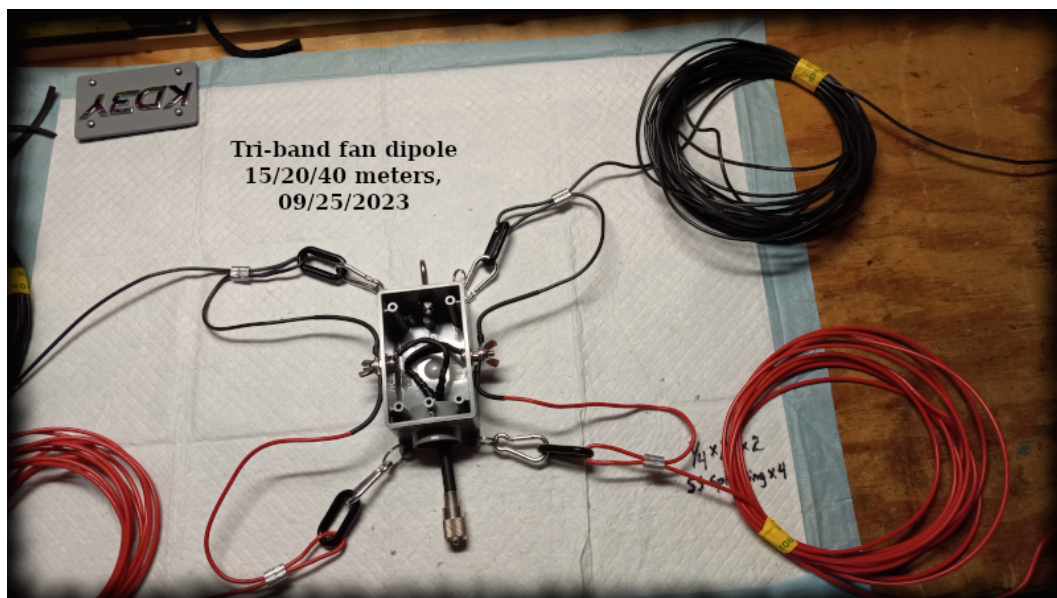
In a dipole antenna design, the highest voltage is found at the center end of each dipole leg whilst the lowest voltage is found at each furthest end of the dipole leg. Thus, the highest resistance is found at each furthest end of each dipole leg whilst the lowest resistance is found at the center of the dipole leg. The transmitter cycles alternating current through each leg of the dipole, and each leg is always the inverse polarity of it's counterpart. Instantaneously, the dipole is charged negatively on one leg, beginning at zero and rising to a maximum charge proportional to the power supplied by the transmitter; then the charge decreases to zero. That leg of the dipole becomes charged positively on the next half-cycle of the existing waveform. This process creates a rising and falling electric field from one leg of the dipole to the other, which moves away from the antenna. Similarly, the current in the dipole establishes a magnetic field encircling the dipole, which also moves away from the antenna. The electric and magnetic fields together form the radiated electromagnetic field, which is the "radio signal" that is heard by the receiving antenna. In an ideal dipole antenna design, identical current will exist on each leg of the dipole. Any type of conductive metal wire can be used to make the legs of a dipole; copper being the best conductor whilst steel being the most durable conductor. Copper is a soft metal and tends to stretch, causing the dipole leg to snap in high winds, yet steel is a poorer conductor and is susceptible to corrosion. So oftentimes, copper coated steel wire is preferred as a trade off between superior conductivity VS strength.

A German physicist named Heinrich Hertz first demonstrated the concept of the dipole antenna in 1887, and an Italian inventor named Guglielmo Marconi perfected the design. Marconi was able to design dipole antennae in the early 20th century to achieve long-distance radio communications from ships at sea. At that time, telegraph was the main means of long-distance communication, but it required stations to be connected by wires. Many lighthouses and certainly ships at sea couldn't be connected together by a cable, so Marconi set out in 1897 to invent a wireless communication system. By 1910, Marconi had equipped most passenger ships operating in the Atlantic

with his wireless radio. Marconi's wireless transmitted about 300 miles during the day and about 800 - 1,000 miles at night due to the refraction of the radio waves in the Earth's ionosphere. Titanic was outfitted with the best wireless equipment Marconi had to offer, and her multi-wire "T" dipole antenna was over 150 feet in height, ran nearly 400 feet in length between Titanic's fore and aft smokestacks, and was made of #18 B&S uninsulated silicon bronze wire.

I have talked to other hams in Italy, Germany, Germany, Japan, the Caribbean, and Ireland with my home made 20-meter dipole HF antenna.

In 2024, plans for building my tri-band fan dipole were published in the Pamlico Amateur Radio Club newsletter. Both the plans and the white sheet can be downloaded free from the RESOURCES page at www.SOBXnews.com.



But wait! You said it was a tri-band dipole. It only has dipole legs for two bands!

That's right. The top dipole (black wire) is approximately 66 feet long, tuned to the 40-meter high-frequency ham band. This dipole resonates at 7000 to 7300 kHz, with the center band being 7150 kHz. This is a half-wave dipole antenna.

The bottom dipole (the red wire) is approximately 33 feet long and is tuned to the 20-meter high-frequency ham band. This dipole resonates at 14000 to 14350 kHz, with the center-band being 14150 kHz. This is a half-wave dipole antenna.

Now since the 15-meter high-frequency ham band is resonate at 21000 to 21450 kHz, and we know that 21000 kHz is the third harmonic of 7000 kHz ($7,000 \times 3 = 21,000$), your 40-meter dipole (black wire) will be resonate at both the 40-meter and the 15-meter ham bands. In other words, the 40-meter dipole (black wire) acts as a half-wave dipole at 7150 kHz, but also performs as a quarter-wave dipole at 21225 kHz, giving you the 15-meter band as well.

So you get three for the price of two!



FCC Amateur Extra License KD3Y
ARRL Volunteer Examiner KD3Y

NOTE: These measurements are approximate, so some final length adjustment (tuning) will be necessary. Wire length will change slightly due to antenna height, wire diameter, and ground conductivity variations...and remember to keep your dipole antenna away from overhead power lines else your dipole may turn you into "*The fried crispy squirrel in the electrical Substation*".