Non-Resonant vs. Resonant Antennas

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Let's look at a resonant dipole, Figure 1(a), a too-long non-resonant dipole, Figure 1(b) and a too-short non-resonant dipole, Figure 1(c).

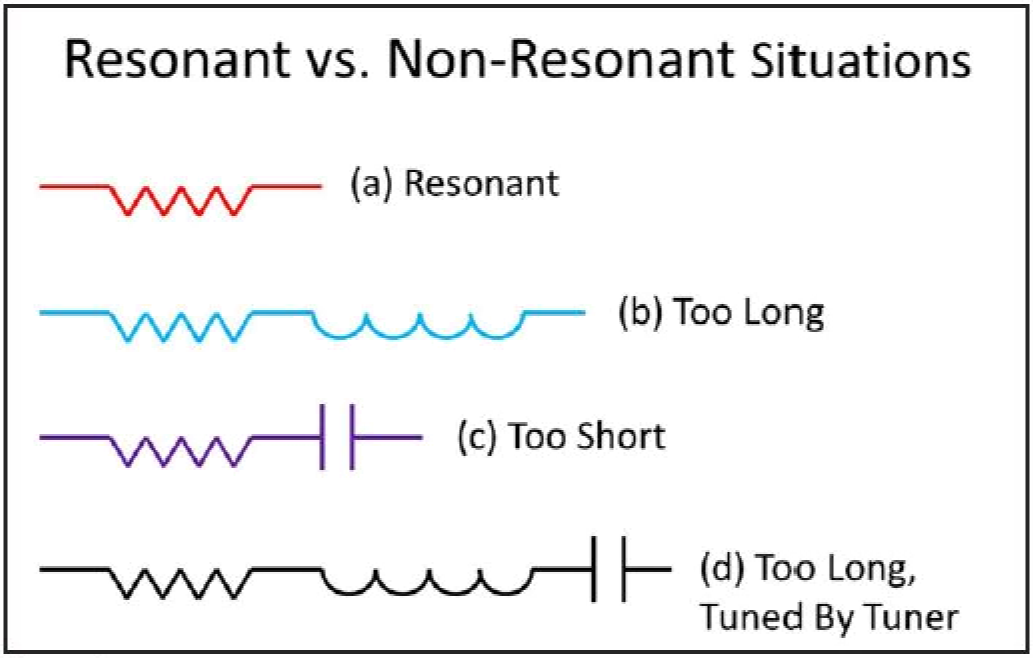

Figure 1.

The resonant antenna looks just like a resistor. If the dipole is a half-wave above ground the resistor is 70 ohms. But it is not an ordinary resistor that turns the current passing through it into heat. This resistor turns the current into electromagnetic waves that radiate outward to distant places and allow us to communicate with one another.

There is a little bit of ordinary resistor in it - the resistance of the wire from which the dipole is made. But we almost always use large enough wire, or even aluminum tubing, to make this resistance very small compared to the radiation resistance. So we can neglect it in our present discussion. The usual dipole is 99 percent efficient or better.

Suppose the dipole is too long for the frequency. Now it looks like **Figure 1(b)**, the same radiating resistor as before but with an inductor in series. This inductor's reactance increases rapidly as the antenna is lengthened and can be much more than 70 ohms. The total series impedance is now higher than 70 ohms. To get the same radiated power – the same current through the resistor as before – we have to apply a higher RF voltage. Our 50 ohm transmitter may not be able to do this but let's suppose we have an RF generator that can do it.

The resistor radiates exactly as before because it carries the same current as before. The inductor produces a magnetic field during one-half of the RF cycle. On the other half-cycle, the field collapses and returns the energy to the circuit. There is no loss, so the efficiency of the too-long antenna is just as good as that of the resonant antenna.

If the antenna is too short for the frequency, then there is a capacitive reactance in series with resistor, **Figure 1(c)**. If we apply enough RF voltage to get the same current through the resistor, the result is the same. Only this time the capacitor charges during a half-cycle of the RF and discharges during the other half-cycle. No power is used and, again, the non-resonant antenna radiates just as well, and with the same efficiency, as a resonant antenna does.

If the inductive or capacitive reactance is too high for our transmitter to drive the antenna, we use a tuner to reduce the reactance to zero. In the case of the too-long antenna of Figure 1(b), the tuner adds an equal capacitive reactance as shown in Figure 1(d). The current in the inductor lags the current in the resistor by 90-degrees. The current in the capacitor leads the resistor current by 90-degrees. So these two currents are 180-degrees apart.

If we make the two reactance equal, then the two currents cancel and our transmitter sees just the resistor - it can drive it just as though it was a resonant antenna. The inductor is still there and so is the capacitor that the tuner added. Current flows through both of them but there is no loss in either.

The non-resonant antenna radiates just as well as a resonant antenna.