PROJECT BUILD

Extend Your Handheld's Range with a Simple Ground-Plane Antenna

Parts List

- A female SO239 chassis-mount coaxial connector
- Five feet of #14 electrical house wire
- Heavy-duty wire cutters
- Pliers
- Heavy-duty soldering gun, or a gas torch
- Rosin-core solder
- Coaxial cable
- An adapter to attach the coaxial cable to your handheld transceiver when the antenna is finished.
- PVC pipe
- Hose clamp

TIP The type of adapter needed will depend on the connector your radio uses. Most use SMA connectors, either male or female. You can find adapters on Amazon or at amateur radio dealers.

If you're using a handheld transceiver on a VHF or UHF frequency, you've probably learned by now that the radio's small, flexible antenna — sometimes called a *rubber duck* antenna — limits you to a few miles at best, unless you're on top of a mountain or tall building, or if you have a repeater to help relay your signal.

One of the easiest and least expensive ways to extend your range is by using a *ground-plane* antenna. It's called a ground plane because the wires that stick out to the sides — called *radials* — act as ground returns for the energy your transceiver generates. All antennas need ground returns — even the antenna on your car, where the ground plane is the body of the car itself. Many commercial ground-plane antennas have three or four radials. This simple design uses only two.


Step 1

Cut at least three lengths of the #14 wire (remove any insulation), according to the length needed for the frequency you desire. Though this is a single-band antenna that will work on only one frequency, you may be able to it use with a dual-band VHF/UHF transceiver if you cut the wires for the 2-meter band.

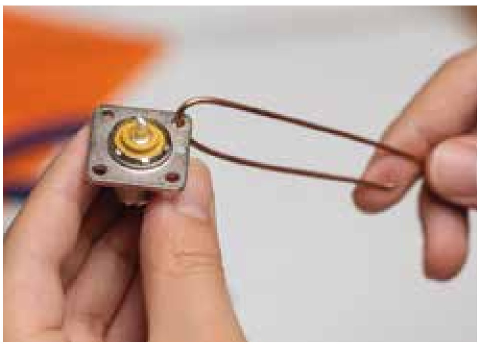
Band	Frequency (MHz)	Wire Length (Inches)
2 meters	146	19 1/4
1.25 meters	223	12 1/2
70 centimeters	440	6 1/4

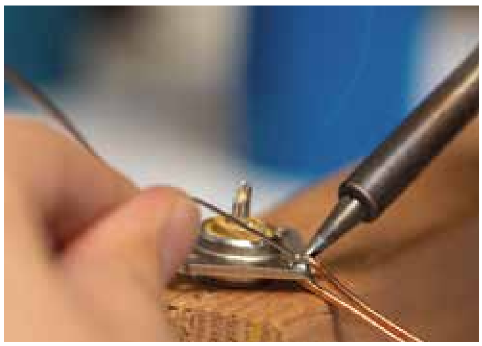
Of the three wires you've created, two will become radials and one will be the radiating element, better known as simply *the element*.

TIP To eliminate sharp ends, bend one end of each wire into a circle.

Step 2

Pass the radial wires through the holes in the chassis mount of the coaxial connector. Choose holes that will place the radial wires are opposite one another. Use your soldering gun or torch to solder them into place.





TIP It takes a lot of heat to accomplish this, so sometimes a torch is best.

Step 3

Insert the element wire into the center pin of the connector and solder it into place. This is the pin that is on the opposite side of the threaded part of the connector.

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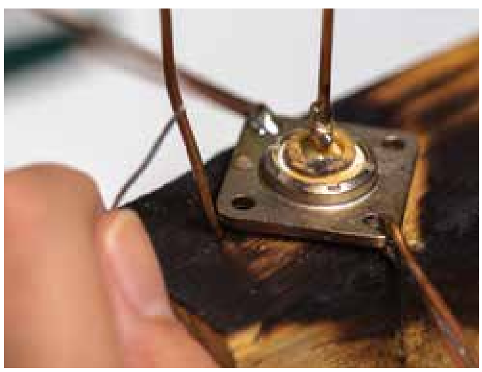


What is SWR?

To understand the concept of *standing wave ratio*, or SWR, imagine a small pond with a vibrating motor in the center. Those vibrations make ripples radiate outward in all directions. The ripples strike the soil at the edge of the pond and bounce back in the general direction of the motor. These reflected ripples collide with the "new" ripples being generated by the motor. As they collide, they add or subtract from one another.

If we were to watch from the shore, we'd see the first ripples striking the pond edge and returning, but within seconds we would no longer see moving ripples at all. Instead, we'd see what appeared to be a fixed, non-moving pattern of waves on the pond's surface. All the traveling waves would collide and merge into a series of *standing waves*.

Similarly, the energy your transceiver sends into the coaxial cable, the *forward power*, travels to the antenna. Some of the energy is radiated, but some is reflected. This *reflected power* goes back down the coax toward the transceiver, where it will ultimately bounce back to the antenna. Along the way, it encounters forward power from the transceiver. These waves of energy interact, adding and subtracting. The result is standing waves on the cable.

SWR is important is because it can play an enormous role in determining how much RF energy is lost in a coaxial cable. As the SWR increases, more RF energy is tied up in the standing waves along the cable, and it will be lost as heat. A high SWR can also damage your radio, especially at higher power levels. That's why many transceivers have circuits that automatically reduce their RF output if the SWR rises above 2:1.

Mounting the Antenna

Use a length of PVC pipe as a mast for your antenna. Cut slots into one end to create flexibility in the width of the pipe's opening, and use a hose clamp to squeeze the pipe around the bottom of the coaxial connector to hold it in place inside the end of the pipe.

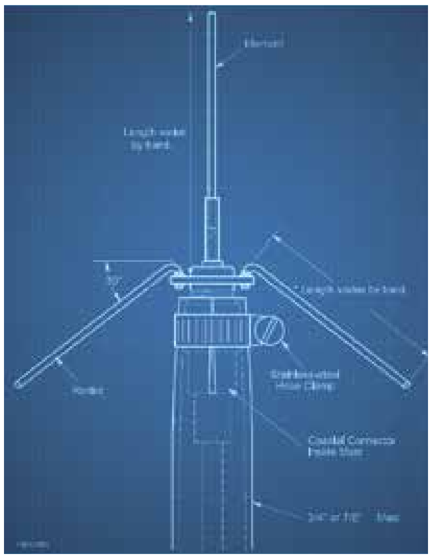
In the drawing at right, note that the coaxial cable is fed through the inside of the pipe where it finally screws onto the connector.

Testing the Antenna

Bend the radial wires down to 30-degree angles (approximately) as shown in the drawing. If you have an antenna analyzer, or know someone who does, attach it to the coaxial cable and measure the standing wave ratio (SWR) at your desired frequency.

If the SWR is greater than 2:1 at your desired frequency, measure above and below the frequency. If the lowest SWR point occurs below the frequency you want, your element wire is too long. Trim the wire by 1/4 inch and measure again. Keep cutting a bit at a time until the lowest SWR occurs at the desired frequency. See the sidebar, "What is SWR?"

On the other hand, if you find the lowest SWR at a frequency higher than the frequency you desire, your element wire is too short. You'll have to remove the wire and replace it with a longer one. Make the replacement wire about an inch longer. In this way, you can trim the wire to bring the low-SWR point exactly where you want it. Once your SWR is under control, you're ready to get on the air with an increased range, thanks to your new ground-plane antenna!



The diagram of our simple ground-plane antenna, using PVC pipe as a support mast.