When most people think of the word "ground," they immediately imagine the soil beneath their feet, but it is much more. In fact, grounding — and the related idea of bonding — are complex topics with misinformation in abundance. Here are some basics drawn from the ARRL book *Grounding and Bonding for the Radio Amateur* by H. Ward Silver, NØAX. We'll only scratch the surface here (no pun intended!), but you can pick up a copy of the book at arrl.org/shop for a more in-depth treatment, along with practical advice.

A Ground-Level Look at Grounding

The word "grounding" — meaning a connection to the Earth — is casually applied to so many different purposes in amateur radio, it's no wonder there are many opinions and misconceptions about it. "Bonding" is a less familiar term to most amateurs. In the electrical sense, bonding simply means "to connect together." Figure 1 gives a couple of examples of each type of connection commonly found in an amateur's home station.

Grounding and bonding can be made to sound complex and difficult, but it doesn't have to be that way! Professional station designers and safety engineers have spent countless hours finding the best ways to protect equipment and operators. By following their standard practices in your station, you can get the benefit of their experiences. What is important is that you have a grasp of the fundamentals.

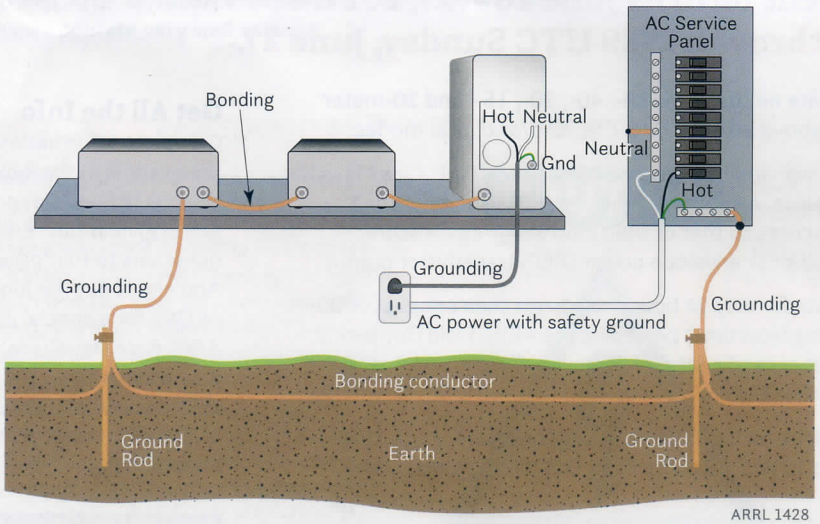


Figure 1: Grounding means "to make a connection to the Earth," while bonding simply means connecting equipment or connections together to minimize the voltages between them, which can sometimes cause problems. This figure shows a couple of examples you might find in a typical ham radio station. (These are just examples to show what bonding and grounding are.)

Why Are Grounding and Bonding Important?

It makes sense to pay careful attention to grounding and bonding in a home station for at least three reasons:

- **AC safety.** You need to protect against shock hazards from ac-powered equipment. You do this by providing a safe path for current should something go wrong. It's better to have dangerous currents going to ground through the appropriate connections, rather than through your body!
- **Lightning protection.** Regardless of where you may live, lightning is a concern. Nothing short of a professional (and costly!) lightning-protection system will save your equipment from a direct hit, but good grounding and bonding can at least save your station from damage by nearby strikes.

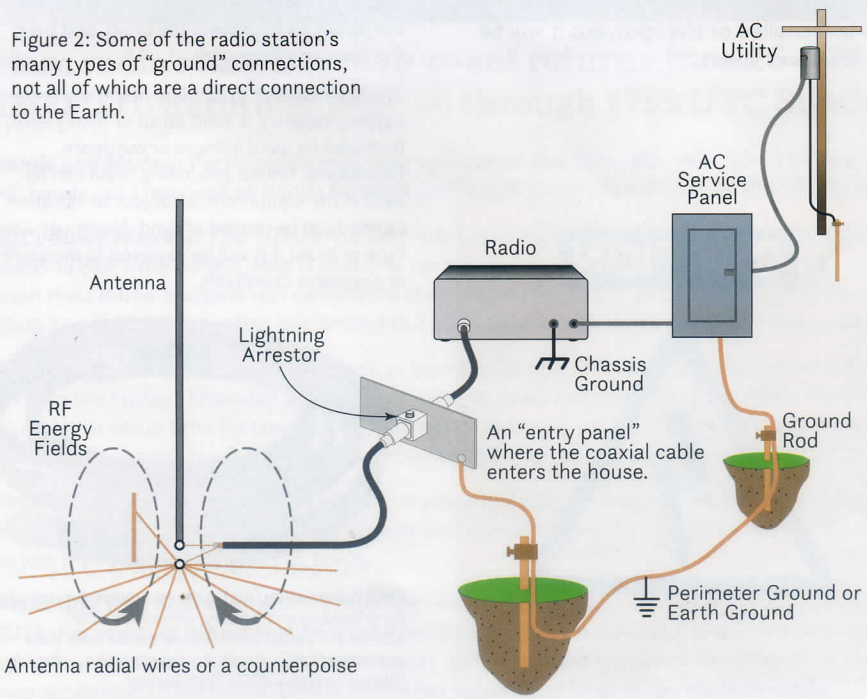
- **RF management.** This is a fancy way of saying that you want to prevent unwanted RF currents and voltages from disrupting the normal functioning of equipment in your station by what is known as *RF interference* or *RFI*.

Why Is Grounding So Complicated?

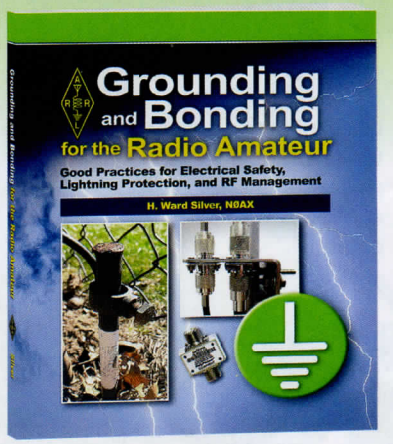
The very word — grounding — means different things depending on who you're talking to and what you're talking about. Isn't grounding just connecting equipment to the Earth? That is certainly one definition of grounding. The British use the terms "earthing" and "protective earth conductor," which are more exact references to what the connection is for. But the layer of soil and rock at the Earth's surface is not a magic sponge into which we can pour any amount of electric charge where it safely disappears! The current's strength and frequency, soil characteristics, whether the soil is wet or dry, the length of the path to the Earth connection and through the soil — all of these have a direct impact on what our equipment experiences at the "ground" connection. Figure 2 shows a few of the different things that get involved when talking about "ground." As you can see, there are lots of choices!

- To the electrician, "ground" connections in your residence are a way of or protecting against ac shock hazards.
- In the ac power grid, the utility uses "ground" connections along the power lines to stabilize voltage in the ac power system. This is done for lightning safety, or in case something goes haywire in the power system.
- Long copper rods known as *ground rods* installed in the soil outside your residence help minimize the damage a lightning strike can do in your house or station.

Figure 2: Some of the radio station's many types of "ground" connections, not all of which are a direct connection to the Earth.



Protect your ham radio equipment



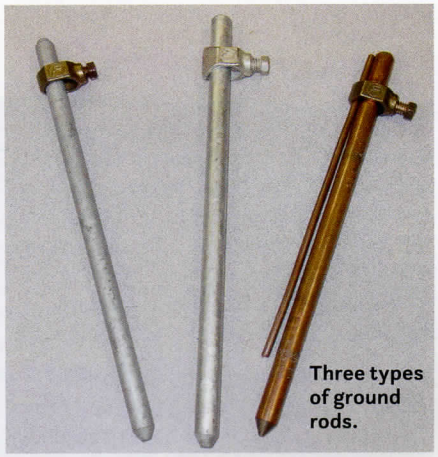
ARRL'S *Grounding and Bonding for the Radio Amateur* by H. Ward Silver, NØAX, provides practical techniques to help protect your station against unexpected electrical events.

Learn how to safeguard your electrical equipment, reduce squelch, and eliminate unwanted RF in your station by properly grounding and bonding your stations, towers, and antennas.

Order at **arrl.org/shop**

ARRL the national association for amateur radio®

- When it comes to antennas, the term "ground" might refer to a counterpoise that gives RF energy generated by your radio an electrical pathway to complete the antenna circuit and radiate your signal more efficiently. Elsewhere in this issue, you'll see counterpoises mentioned in our discussion of end-fed half-wavelength (EFHW) antennas.
- Circuit designers and station builders refer to "ground" as a common reference voltage. For example, the metal box that houses your radio is connected to the negative terminal of the radio's power supply. In this situation, the entire box is said to be "at ground potential."



Three types of ground rods.

The Ground Challenge

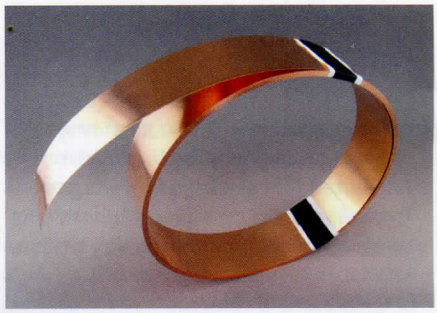
While all home stations can benefit from thorough grounding, some situations are more challenging than others. What if your station is on the second floor of a house, many feet from where you might be able to install a ground rod? Worse yet, what if your station is in an apartment or condo, where you aren't allowed to make additional grounding connections?

The good news is that your station doesn't necessarily need a ground system to function well. After all, radios in airplanes and vehicles operate very well without connections to the Earth! But understanding the concepts of grounding and bonding can pay dividends in protecting you and your equipment from hazards, and in helping to solve annoying problems such as RF interference.

If you want to improve your station ground at home, follow the advice found in *Grounding and Bonding for the Radio Amateur*. It is also a good idea to contact a local electrician and have them inspect your station wiring. Show them your equipment and explain your grounding concerns. There will obviously be some cost involved, especially if wiring needs to be installed or changed, but it will be money well spent.

You're a Lot Slower than Electricity!

We've all experienced the temptation to make a very quick "swipe" of a wire to see if it's "hot." This is *not* a good way to learn about how fast electricity can move. With effort, you might be able to move your finger a few feet per second, but electricity moves millions of times faster. As fleeting as the contact might be to you, there is plenty of time for current to flow and deliver a full-strength shock. So please put that temptation right out of your thoughts, and be sure that any visitors to your shack are aware of the danger.



Using the Right Materials

It's natural to want to reuse what looks like perfectly good braid from an old piece of coax. After all, it was good enough to conduct RF in a piece of coax, so why wouldn't it make a good ground conductor for RF equipment?

Here's why. The braid in coaxial cable is woven around the insulating dielectric of the cable in a continuous process. It's pulled tight against the dielectric as the cable is manufactured, and then is covered with a protective plastic jacket. As long as the jacket compresses and protects the braid, all of the braid wires remain clean and in good contact with each other.

However, once the braid is removed from the protective jacket, the braid wires immediately begin to loosen and oxidize or corrode. This reduces the braid's effectiveness at conducting RF quite a bit, making it a poor choice for long-term grounding conductors.

To use the coax as a ground conductor, leave the jacket on to protect the braid, and treat the coax as a large wire.

The standard for grounding in the communications industry is solid strap or heavy wire. Both can be used indoors or outdoors. Flat-weave, tinned grounding braid can be used if the equipment is subject to vibration or needs to be moved around. Never use any type of braid if it will be exposed to moisture or corrosive chemicals.

Solid copper strap (top) is the recommended material for grounding and bonding connection at RF. Flat-weave tinned braid (above) can be used if it's protected from water and corrosive gases or liquids [Photos courtesy of DX Engineering]