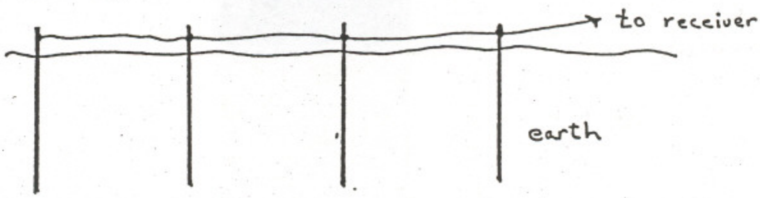
IMPROVED RECEIVER GROUNDS

Most of us have a mental picture of a "ground" as a long copper rod or water pipe in soil and clamped to a wire leading to a receiver. More generally, a ground is a point of zero potential, or a reference point. For example, the chassis of a receiver is regarded as a ground by the circuits of the receiver, while the zero reference point for the "live" side of the AC powerline is the earth itself. An external ground is an attempt to place a body of metal (the pipe or rod), and the receiver chassis to which it is connected, at the same potential as the earth itself.

It's usually recommended that a receiver be attached to a "good ground" (one which is closest to earth potential) in order to reduce electrical noise, prevent electric shock, and to improve signal strength. Ideally, the resistance between a ground rod and the earth as well as the ground rod and the receiver should be zero. It should be easy to keep resistance low between receiver and rod...just use very thick wire. Actually, copper braid or tubing presents a lower resistance (impedance is a better term) to RF at medium and higher frequencies. Also, one should keep the physical length between receiver and grounding clamp to a small fraction of a wavelength; at 1600 kHz, this should be well under 50 feet, and less yet at higher frequencies. Clean, bright metal on the rod, cable and clamp where they touch each other goes without saying.

Resistance from a ground rod to earth itself is most dependent upon the electrical conductivity of the soil and to the length (rather than the diameter) of the ground rod. Six feet or longer is usually recommended. Use copper clad steel rods unless your local soil is very soft, as copper pipe will bend when stressed. Still lower resistance may be obtained by connecting several ground rods together in series, with at least 6 feet separation between each rod. See below:



Soil conductivity is better in damp clay or muck soils, worse in dry sandy soils. One can't do much about the soil type at a site, but moisture can be added out to a foot radius around a rod. Further than that doesn't improve conductivity much except in very sandy soils. Conductivity is further enhanced by the addition of rock salt or Epsom salts to the area, though these may damage nearby plants, and could encourage rod corrosion. In areas of heavy rainfall, salt will have to be renewed every year or two.

The above paragraphs describe a good conventional ground. In fact, it would be a good ground for connection to the point where your AC powerline enters the house. However, it's often observed that hooking up an external ground to a receiver can actually make local noise worse due to ground loop currents, and that signal strength does not improve when using a random wire antenna. (Note that an external ground is not

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likely to improve signal strength when using a dipole or loop antenna.) Yet Patrick Martin observed that signal strength on the Australian stations he was receiving with his 200 foot random wire improved as he added more rods to his system at six foot intervals.

Patrick's case points out a sad truth...to get a ground to improve signal strength or to reduce noise, it must be an excellent ground, not just a good one. Most of us don't have the conductivity of the Oregon shore groundwater to help us, even if we have a store of ground rods.

DO WE REALLY NEED AN EXTERNAL GROUND?

Although AC powerline ground may make reception noisy, for many listeners it appears to be at least as good a receiver ground as a single ground rod. This is probably due to either capacitive coupling from powerline to receiver chassis, or to direct connection to chassis from the third pin of the AC plug. In some receivers (older ones with inductive coupling from the antenna to the rest of the receiver), powerline ground may also provide a bleed-off path for precipitation static built up on a random wire.

However, AC ground (or any easily constructed ground) will not provide protection from direct or nearby lightning strikes. The best and easiest protection for the listening post is to configure the antenna lead-in so that it can be easily disconnected where it enters the building. When lightning threatens, the antenna lead-in may be grounded externally to the building or it may be left hanging. In addition, pulling out the AC power plugs to your equipment is also advisable.

What about the safety net that an external ground may provide? You don't want to get a lethal shock from a receiver front panel if something goes wrong internally. Newer receivers should have passed various underwriters' safety tests to be allowed on the market; if a safety ground is required, it will be provided via a 3-pin power plug. Older receivers should be assessed on a unit by unit basis before external grounds are connected; there may be a potential difference between chassis and earth even when the receiver is operating correctly.

So, does this mean that one shouldn't bother with an external ground if using a newer receiver? If one listens only above 5 MHz, that may be true, but for medium wave listening there are approaches which will make an external ground beneficial.

First of all, your AC powerline ground may not be that good an RF ground; it may be a good fraction of a wavelengh away from the receiver for example. A single or multiple ground rod system may provide signal improvement and improved noise response in such a case.

For example, my antenna is a horizontal loop about 130' circumference at 15' high (using a 15' downlead). For frequencies up to a few MHz, this corresponds to a short vertical with a sizeable capacity hat. Using a ground system of four series connected 6 foot long ground rods each separated by about 6 feet gave up to 12 dB gain over powerline ground alone and up to 5 dB gain over a single ground rod. Less electrical noise was received as well over either powerline ground or the single rod. These observations seem to verify conventional wisdom, i.e. the ground with the lowest resistance to earth (the collection of 6' ground rods), delivered the better signal strength with the lowest electrical noise, at least through 2500 kHz. Above 2500 kHz, that ground quickly lost its advantage over a single rod or over the powerline ground.

However, Bill Bowers in Oklahoma apparently has a good powerline ground, as he noted no improvement when using a more elaborate ground system than mine. Unfortunately, building a multiple rod system only to find it doesn't improve matters could be mightily aggravating. Is there a better approach?

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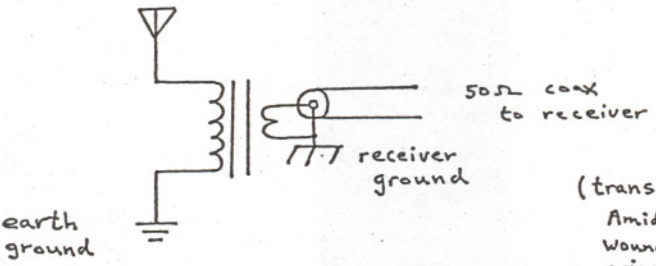
Yes, there is, and it has already been mentioned several times in DX Monitor. Graham Maynard in the Technical Column of August 8, 1987, Denzil Wraight's "Interference Reducing Antennas for BCB" (July 25, 1991, reprint A107) and Dallas Lankford's "Inverted L Noise Reducing MF/VLF antenna (August 17, 1991, reprint A108) all showed that to reject electrical noise, it was important to isolate RF ground from chassis ground. This was done using a broadband matching transformer with the external ground connected to one winding and chassis ground connected to the other.

However, I've now found that when a matching transformer is used with my antenna and a single ground rod (still isolated from the receiver chassis; see illustration below), that I got at least as good signal strength (still with less noise) than with the antenna and the four-rod ground system connected directly to the receiver. Below 1 MHz, gains of 4 to 8 dB were common, and remember that the elaborate ground system was already providing substantial gain over the powerline ground alone. The effect was most spectacular when receivers with 50 ohm input impedances were used; receivers with higher input impedances such as many tube receivers, would not show as radical an improvement, but there's a lot less work in one ground rod than in four of them.



(transformer is Amidon FT50-43 core wound with 35-turn primary (minimum) and 11-turn secondary. Also try MCL T9-1 as suggested by Connelly.)

CONCLUSIONS

a) The traditional emphasis in ground system design has been to get as low a resistance to earth as possible, implying deeply driven multiple ground rods. Although AC powerline grounds, lightning protection systems and some transmitting grounds require a low resistance to earth, it is only essential for improved radio reception if one is listening below 3 MHz with a low impedance input receiver and the ground system connected directly to the receiver chassis.

b)Using a matching transformer and isolating the earth ground on the antenna side of the transformer from chassis ground on the receiver side will meet most low band DXers' requirements for improved reception with low response to electrical noise, even when using a "poor" ground. In addition, precipitation static charges will be bled off to ground.