

## R.F. Grounding

by

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For quite a number of years, the author has been presenting seminars, "talks", etc., on the subject of lightning protection and r.f. grounding to various community, professional, and amateur radio organizations. Although these are two distinct subjects, they are definitely "intertwined" in the amateur radio world. A "primer" on lightning grounding has been included elsewhere on this web site, so this will cover the subject of providing grounds for proper r.f. protection.

First of all, the length of the rods used for r.f. grounding are not that critical except when determining the "spacing" between the rods in multiple rod systems. Frankly, in the vast majority of soil types, any rod with a length of over 5 feet is "wasted"! Well over 95% of the effective grounding takes place within the first 5 feet. Thus, anything longer is basically unused!

The effective grounding volume of an r.f. ground rod is a hemisphere with a radius equal to the length of the rod (picture a tennis ball cut in two and then buried until the cut surface is just even with the ground level). In the case of a 5 foot rod, this means a diameter of 10 feet on the surface of the earth with 5 feet going in a circular fashion to the end of the ground rod. In this hemisphere of grounding about 95% of the effective grounding of the rod takes place.

In a practical situation, two 5 foot ground rods, placed the "appropriate" distance apart, "out perform" a single 10 foot ground rod by at least a factor of 2, if not more. Experimentation has shown that a spacing of 2.4 times the length of the ground rod gives the maximum effective ground. You can go closer or farther apart, but the actual effective grounding will be diminished if this spacing is not used. Basically, you want to get the hemispheres of grounding fairly close to each other while not "overlapping". Thus, for ground rods 5 feet long, the spacing should be 12 feet. Additional rods can be added in various geometric patterns (i.e. triangle, straight line, "L", etc.). However, the 2.4 ratio spacing should be maintained. Of course, an "inch or two" either way is not going to have any really noticeable effect on the grounding. But, the ratio should be adhered to if at all possible.

The first ground rod should be installed as close to the wall of the shack as possible with as heavy a wire or braid available run from the equipment (as short a wire as possible). Then, the connections between the various ground rods does not have to be that "heavy" a wire. 14 gauge, or even 16 gauge, wire is quite sufficient.

A definite "improvement" in grounding can be made if a "chemical" type of ground rod is used instead of a solid rod. These are available commercially (made for commercial two-way installations for from \$150 up), you can make your own, or they are also available from Z Communications Company at a price well under the commercial rate! Such a ground rod consists of a 5 foot long piece of "hard drawn" copper pipe with an "end cap" soldered at one end. For equipment grounds, 3/4 inch diameter pipe should be used. For grounds under a vertical antenna (and such), smaller 1/2 inch diameter pipe may be used. I understand that there are 3 grades of copper pipe available and these are often "marked" with the colors red, blue, and green. But, the "green" is a very heavy type of pipe used in industrial applications and is not available at the vast majority of home improvement centers (I have never seen it there!). The "red" pipe should never be used since it is very thin walled. "Blue" pipe is what is used for the construction of these "chemical" grounds.

Hard drawn copper pipe normally comes in sections 10 feet long. This length is "perfect" since cutting it "in two" produces two 5 foot long ground rods. Using a propane "torch" and acid core solder (or, even better, use soldering "paste"), solder an "end cap" onto one end of each rod. Next, starting just above where the end cap "ends" on the pipe, drill a 5/32 inch hole all the way through the pipe. Come up 6 inches, rotate the pipe 90 degrees, and drill a second hole all the way through. Continue to rotate the pipe 90 degrees, come up 6 inches, drill, until you reach about 5 inches below the open end of the pipe. About 1.5 inches below the open end of the pipe, drill another hole all the way through the pipe. Then, enlarge these holes to 1/4 inch diameter.

For the next step you will need a bolt with a diameter of 1/4 inches and about 2 inches long, four 1/4 inch "nuts", and two washers with 1/4 inch holes. Insert the bolt into one of the holes in the pipe. Next, using a pair of "needle nosed" pliers, hold one "nut" and "thread" this onto the bolt. Continue until the "head" of the bolt is flush with the wall of the pipe. Thread a second nut onto the exposed portion of the bolt. Tighten this all the way until it is flush with the outside wall of the pipe. Then, thread the nut inside the pipe until it is tight on the wall where the second nut is. Tighten the outside nut with a wrench until the connection is as tight as you can get it. Using the propane torch, etc., solder the head of the bolt to the outside wall of the pipe. Do the same thing with the outside nut. Place two washers on the bolt and then two more nuts. The ground wire(s) is (are) placed between the two washers, the third nut is then tightened with a wrench as tight as possible, and the fourth nut is used to "lock" everything in place. Prepare the second (and additional rods if desired) in the same manner.

Drive the first ground rod into the ground as near the outside wall of the shack as possible. Take the rod down until the bolt is just above ground level. If you use a large hammer, the end will be distorted, but this will be OK. Some people like to use a fence post driver (used to drive the metal posts for wire type fences) which cost around \$20 at the home improvement center. This does not distort the end anywhere near as much as a hammer. Drive the next rod 12 feet away. Connect the ground wire from the shack and one end of the "tie" wire (wire that goes between the ground rods) to the first ground rod. Use of terminals on the end of the wires will definitely "facilitate" making of these grounds. For best reliability, not only "crimp" the lugs, but solder them as well. Connect the "far" end of the "tie" wire to the additional ground rod. Under no circumstances try to "wash" the ground rod into the ground using a garden hose!

Fill both ground rods with "rock" salt ("ice cream" salt) that is available at virtually any grocery store. You will probably have to "hit" the side so that the salt will not "clump" and goes all the way down into the rod. In about 2 weeks, come out and "top" off with more rock salt. Then, about every 6 months "renew" with more rock salt. As the rock salt "leeches" into the ground, it improves the r.f. grounding several times what the "normal" ground will be. Also, the rock salt will not harm the grass, etc.

Inside the shack, I recommend having the equipment desk on the same wall as the ground rod. If this is not possible, I will make suggestions a bit later in this article. If aluminum "flashing" is placed on the desk, wall, etc., and the ground wire is taken from that to the outside, a convenient place to make grounds is made. Use short pieces of braid (that removed from old RG58/U coax is very "cheap" and is of excellent quality - much cheaper than buying braid!) to go from each piece of equipment including receiver, transmitter, transceiver, linear, antenna tuner, etc. Copper flashing is technically slightly superior to aluminum. However, the cost is several times that of aluminum (both are available at home improvement centers). The width of the flashing is much more of a factor in grounding than the material (the wider the better). Thus, you can get aluminum flashing much wider than copper flashing for less money.

If you cannot get the operating position on the same wall as the ground rod, then you need to run aluminum flashing from the operating position to the outside wall. Again, the wider the better. This can be run along the wall, under the rug, etc.

The same thing goes for shacks that are not on the ground floor. If you must have a shack on the second floor of your abode, then you need to run aluminum flashing down the wall (usually from a window) to the ground rod system. In this case, you will need to get the operating position as near the window (or outside wall) as humanly possible. You are already operating with two strikes against you! Use as wide aluminum flashing as you can "get away with".

Diagrams showing the construction of the rods, placement of the aluminum flashing, etc. are also on this web site.

If you have all of the tools necessary to construct the ground rods (propane torch, electric drill and bits, tubing cutter or hacksaw, etc.), then you can make a pair of 5 foot long ground rods for under \$20. If you do not have the tools, or don't want to expend the effort, Z Communications Company does have rods available for sale. They "run" \$50 for the first two ("starter kit") and \$20 for each additional rod. Of course, shipping is extra. Individual rods are only sold with an original order for the "starter" kit or to those people who have purchased "starter" kits previously. All rods come with the "tie" wire and instructions, and are 3/4 inches in diameter.

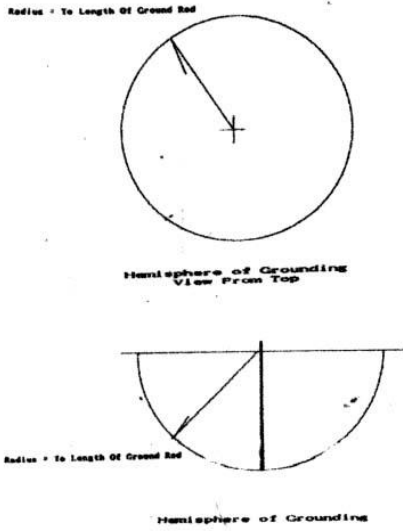


Figure 1: Graphic representation of the "hemisphere of grounding"

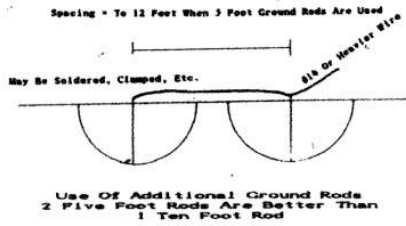


Figure 2: Graphic representation of grounding effectiveness of two ground rods

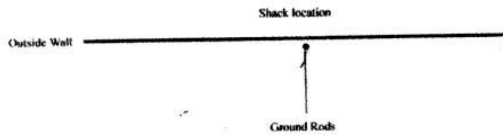


Figure 3: One ground rod should be as close to the shack as possible

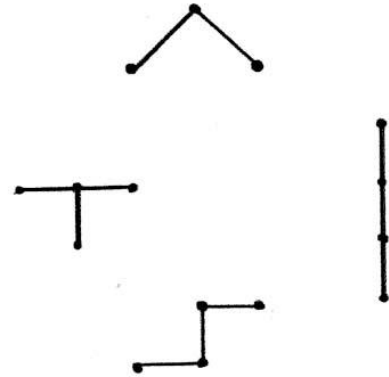
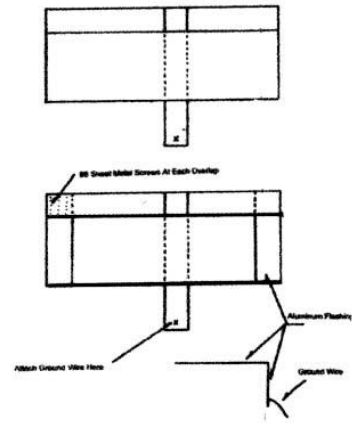


Figure 4: Ground rods can be placed in any geometric configuration as long as they are 12 feet apart for 5 foot long rods.

Desk-Top Ground Planes



Console Ground Plane At K9STH

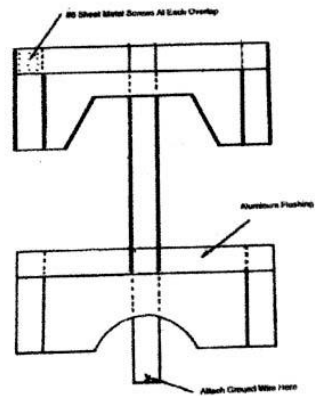
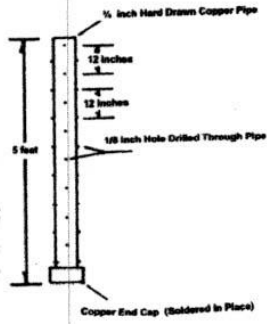
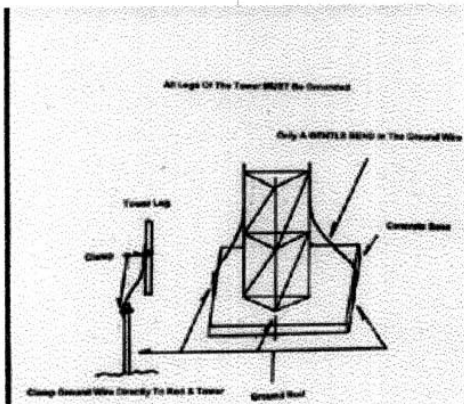
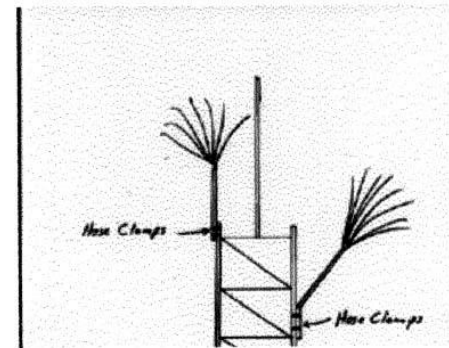
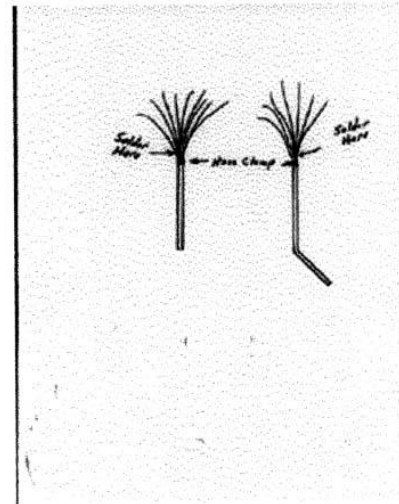


Figure 5: Graphic representations of placement of Aluminum flashing material.

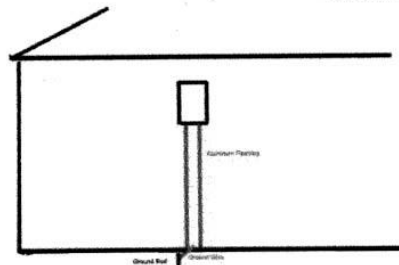
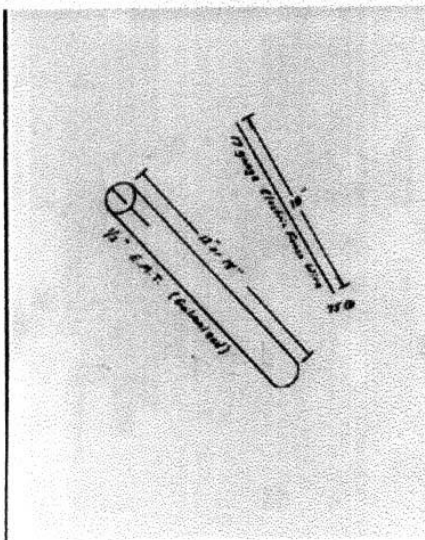
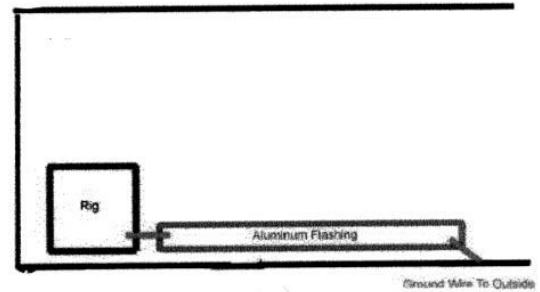


**Details of Chemical Ground Rod**  
**Fill With Rock Salt After Driving In Ground.**  
 (Drawing Not To Scale)

Figure 6: Graphic representation of the ground rod



**Grounding Of The Tower (Or Mast)**  
 Use At Least #6 Stranded Wire  
 Or Heavier (i.e. 000)  
 The Smaller The Number  
 The Larger The Wire



2nd Story Grounding