# Technical Note

Ground Rod Theory Installation

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Ground Saturation

The statement that rods should have a separation, "greater than the sum of their lengths apart," originates from theory, and the fact almost all ground rods will saturate the soil to which they connect. A ground rod connects to localized, irregularly sized, three-dimensional electrical clumps. Depending on the soil make-up (layering, etc.), the volume of earth a ground rod can dump charge into can be generalized as the radius of a circle equal to the length of the rod at the circle's center. This is known as the sphere of influence of the rod. The sum of the driven depths of two rods should be, theoretiin homogeneous soil, the closest that ground rods can be placed. Anything closer will cause the soil (clumps) connected in common to saturate even faster.
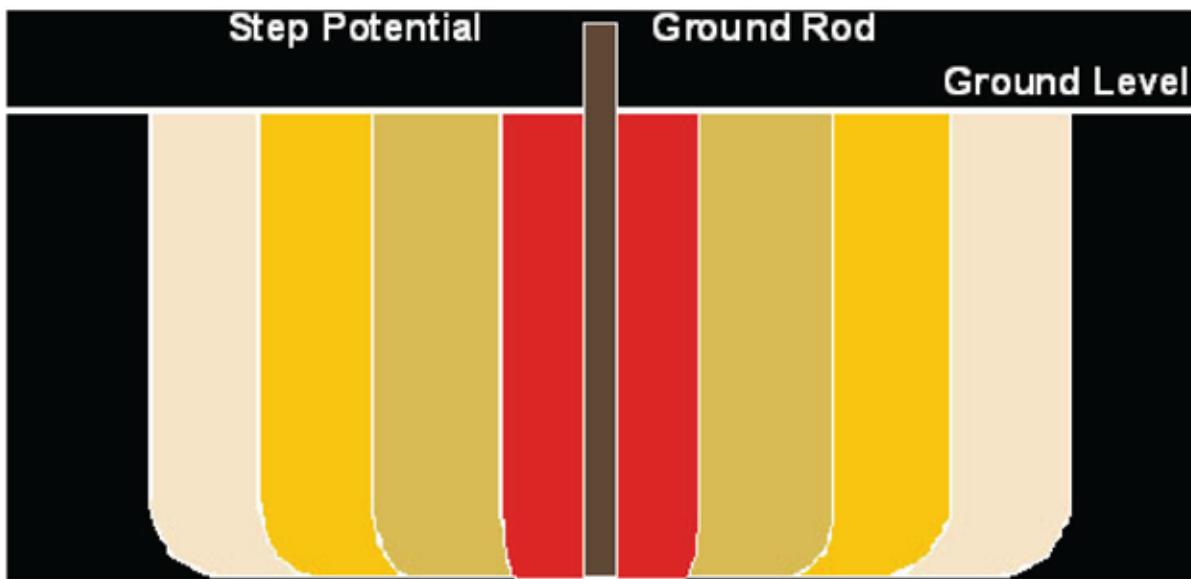
Ground Rod Sphere of Influence

Ground rods come in many sizes and lengths. Popular sizes are 1/2-inch, 5/8-inch, 3/4-inch and 1-inch. The 1/2-inch size comes in steel with stainless cladding, galvanized or copper cladding (all-stainless steel rods are also available), and can be purchased plain (unthreaded) or sectional (threaded). The threaded sizes are 1/2-inch or 9/16-inch rolled threads. It is important to buy all of the same type. Couplers look much like a brass pipe with internal threads and allow two rods to be joined (threaded) into each end of the coupler.

Theoretically, one ground rod with a 1-inch diameter driven in homogeneous 1,000-ohm per meter (ohm/meter) soil for one meter would yield 765 ohms. Driving it two meters into the soil would give 437 ohms. Going to three meters, however, does not give as great a change (309 ohms). One would get faster ohmic reduction and easier installation by using three rods, each one meter long, giving 230 ohms compared to that of one rod three meters long. This assumes they are spaced "greater than the sum of their lengths apart".

If the interconnectwire is also buried below the surface, then the ground system may be less than 200 ohms. (Having one deep ground rod, 40-feet or more, even if it reaches the water table, will not act as a good dynamic ground because the top 5 to 10-feet will conduct most of the early current rise and could become saturated. Eddy currents will form in this top layer and cause the rod's inductance to impede the flow of current to any further depth.)

Ground rods are copper plated for corrosion resistance. Copper, silver, mercury and gold have high resistance to corrosion, while processed metals (never found free in nature) like aluminum and magnesium are easily corroded. Noble metals like copper become the cathode when joined together with less noble metals in the presence of an electrolyte (water). Less noble metals become the sacrificial anode and corrode away.

Not listed in the galvanic table of metals is Graphite, since it is not a metal. Graphite is even more noble than silver and certainly much nobler than copper. Therefore, if a graphite backfill material is to be used as a ground "enhancer" to surround copper, the copper will he sacrificial to the graphite and will dissolve away into the soil.

	Magnesium	Aluminum	Zinc	Iron	Cadmium	Nickel	Tin	Lead	Copper	Silver	Palladium	Gold
MAGNESIUM	0.00	-0.71	-1.61	-1.93	-1.97	-2.12	-2.23	-2.24	-2.71	-3.17	-3.36	-3.87
ALUMINUM	0.71	0.00	-0.90	-1.22	-1.26	-1.41	-1.52	-1.53	-2.00	-2.46	-2.65	-3.16
ZINC	1.61	0.90	0.00	-0.32	-0.36	-0.51	-0.63	-0.64	-1.10	-1.56	-1.75	-2.26
IRON	1.93	1.22	0.32	0.00	-0.04	-0.19	-0.30	-0.31	-0.78	-1.24	-1.43	-1.94
CADMIUM	1.97	1.26	0.36	0.04	0.00	-0.15	-0.27	-0.28	-0.74	-1.20	-1.39	-1.90
NICKEL	2.12	1.41	0.51	0.19	0.15	0.00	-0.11	-0.12	-0.59	-1.05	-1.24	-1.75
TIN	2.23	1.52	0.63	0.30	0.27	0.11	0.00	-0.01	-0.47	-0.94	-1.12	-1.64
LEAD	2.24	1.53	0.64	0.31	0.28	0.12	0.01	0.00	-0.46	-0.93	-1.11	-1.63
COPPER	2.71	2.00	1.10	0.78	0.74	0.59	0.47	0.46	0.00	-0.46	-0.65	-1.16
SILVER	3.17	2.46	1.56	1.24	1.20	1.05	0.94	0.93	0.46	0.00	-0.19	-0.70
PALLADIUM	3.36	2.65	1.75	1.43	1.39	1.24	1.12	1.11	0.65	0.19	0.00	-0.51
GOLD	3.87	3.16	2.26	1.94	1.90	1.75	1.64	1.63	1.16	0.70	0.51	0.00

(Vertical left axis: LESS NOBLE ↑ ; bottom axis: ← LESS NOBLE →)

Noble Metal Table: Accelerated corrosion can occur between unprotected joints if the algebraic difference in atomic potential is greater than ± 0.3 volts.

Please contact us for questions or further information on this topic.

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