Testing an Electrical Ground (Live Demo)

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How do you know if your ground is effective? This demonstration will show you how, using relatively simple test equipment, you can test a ground to determine its resistance.

An effective electrical ground is necessary to establish and maintain the potential of the Earth on electrical and electronic equipment. Such a system is used to control shock hazards and protect against large electrical disturbances.

Also discussed;

How to improve a ground,
Grounding do's and don't's,
Ground resistance, how low is low enough?

Test Equipment used: CEM DT-5300 Earth Resistance Tester

The National Electric Code (NEC) states that a residential grounding electrode must have a resistance to ground of 25 Ohms or less. If this cannot be achieved with a single electrode then a second electrode, spaced at least 6 feet from the first, must be installed.

Twenty-five Ohms may be sufficient for home appliances but ***sensitive electronic equipment*** needs 5 Ohms or less to limit noise and reduce the risk of lightning damage. Lower is better.

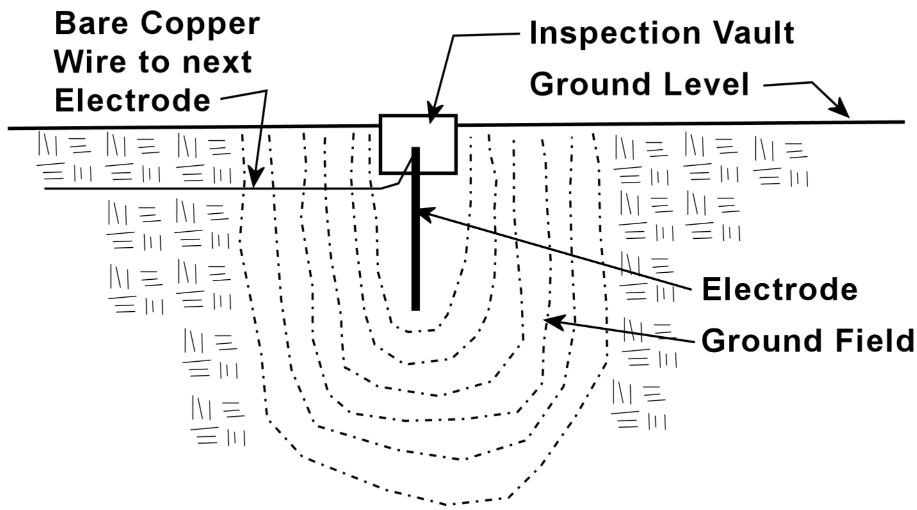
The resistance of an Earth electrode system depends on three things;

1. The resistance of the ground rod (electrode) and connections to it,
2. The resistance between the electrode and the surrounding earth and
3. The resistivity of the Earth surrounding the electrode.

Copper-clad steel electrodes and copper wire with tight-fitting or welded connections take care of item number 1. Item 2 is controlled by the surface area of the electrode. Finally, number 3 is a function of soil type, mineral content, moisture and temperature.

An electrode driven vertically into the soil will have a 'ground field' surrounding it. The radius of the ground field is equal to the depth of the electrode. Thus, an 8-foot electrode will have an 8-foot radius ground field.

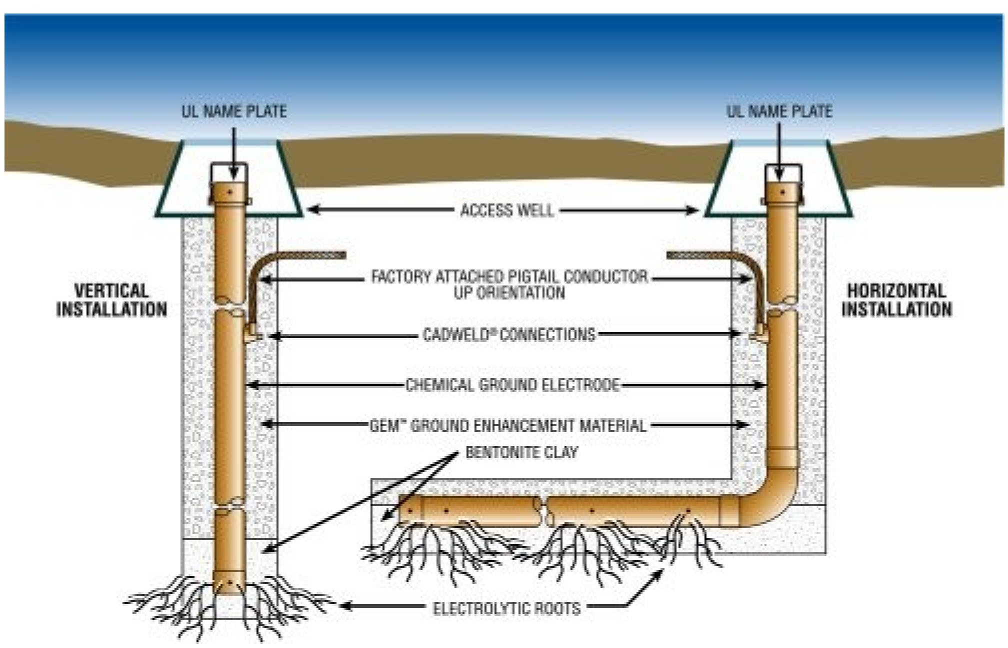
Since overlapping ground fields add little to the system, electrodes should be spaced apart ***at least*** twice their depth. Wires connecting electrodes should be buried 6 to 18 inches deep.



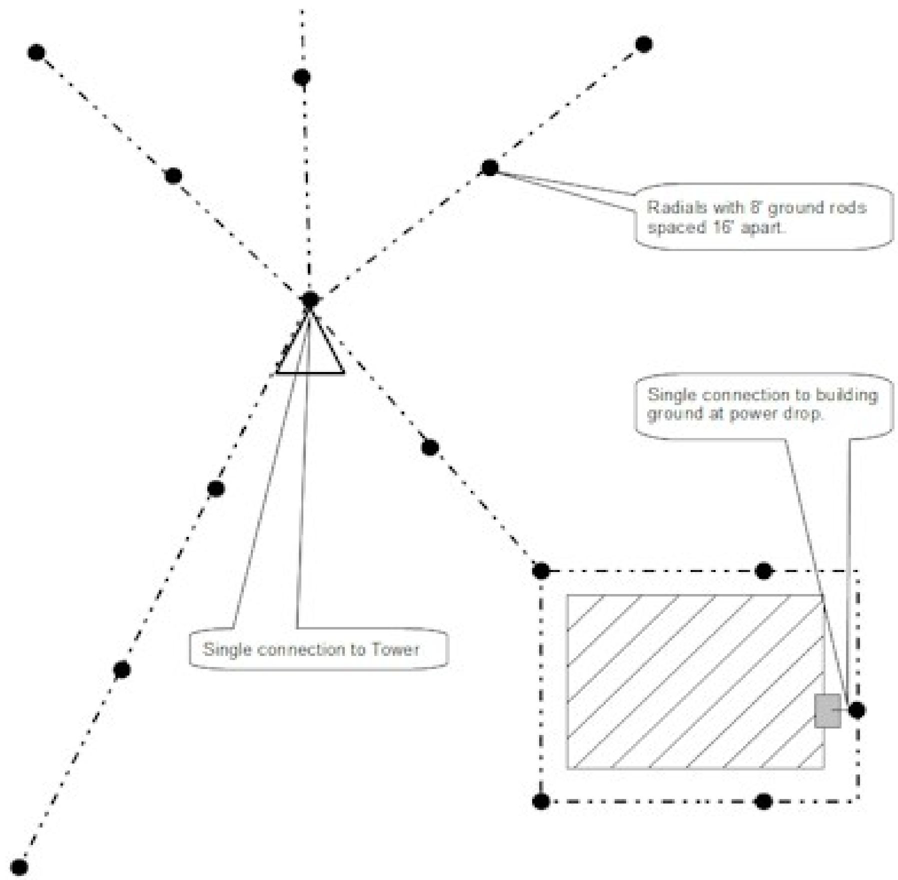
Typical Vertical Electrode.

The longer the electrode the lower the resistance. But there are diminishing returns beyond about 8 feet in length. A more effective way to lower the resistivity of the ground system is to increase the surface area of the electrode. Large diameter copper rods are expensive. It is usually more cost effective to dig a "fence post hole", fill it with a conductive material, and then drive a standard ground rod into the filled hole. A common material used for this purpose is "coke breeze." Coke breeze is a byproduct of the production of coke (the carbon, not the drink), it is the carbon powder that falls through the steel grate in a coke oven.

In very poor soil a chemical electrode may be needed to obtain an adequate ground.



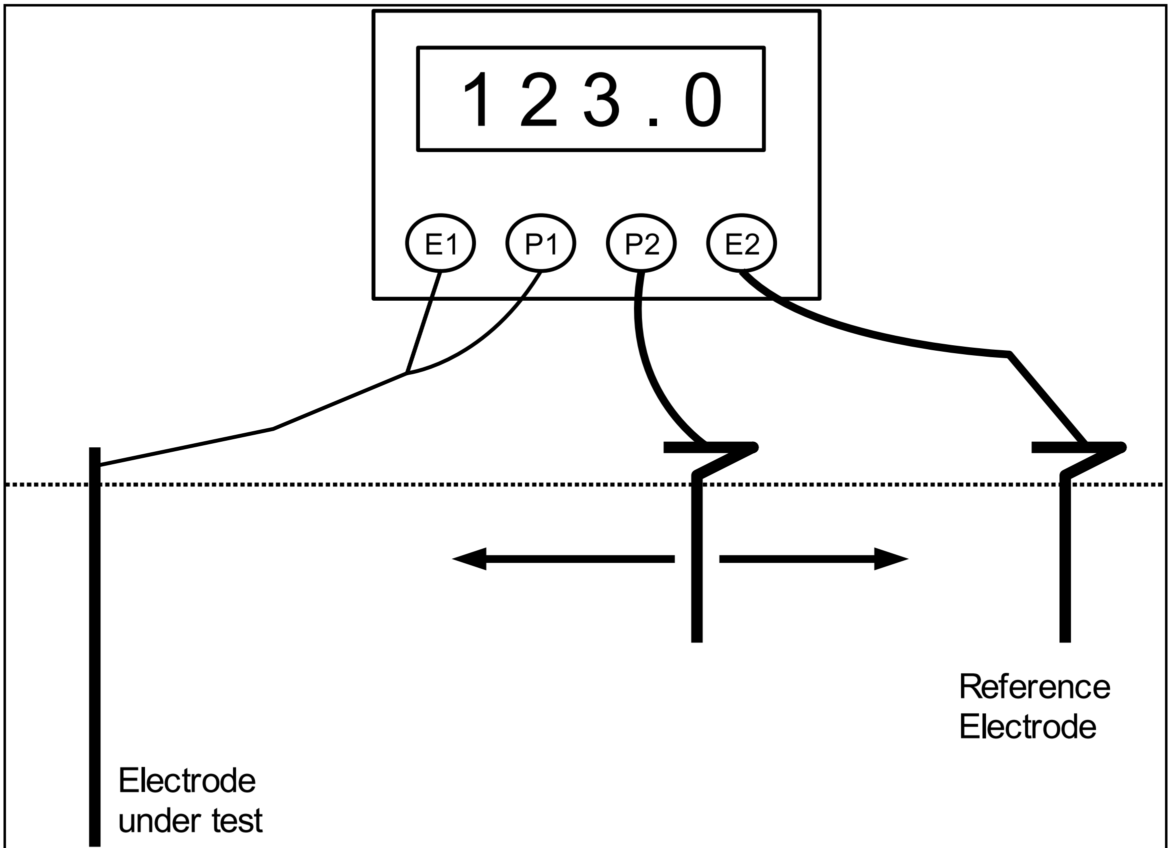
In professional communications sites lightning protection is normally provided to towers with multiple radials of buried copper wire and vertical electrodes radiating out from the tower. These radials are positioned so that they do not run in the direction of the electronic equipment. An equipment shelter located near the tower is shielded by a buried ring of copper wire and vertical electrodes surrounding the building. All grounds are tied together. Connections are made to the ground from a minimum of points to avoid circulating loop currents.



Example Tower Site Grounding System.

One way of determining the resistance of an existing ground system is the Fall of Potential (FOP) method. A ground resistance meter (sometimes called a "megger") is used to make the measurement.

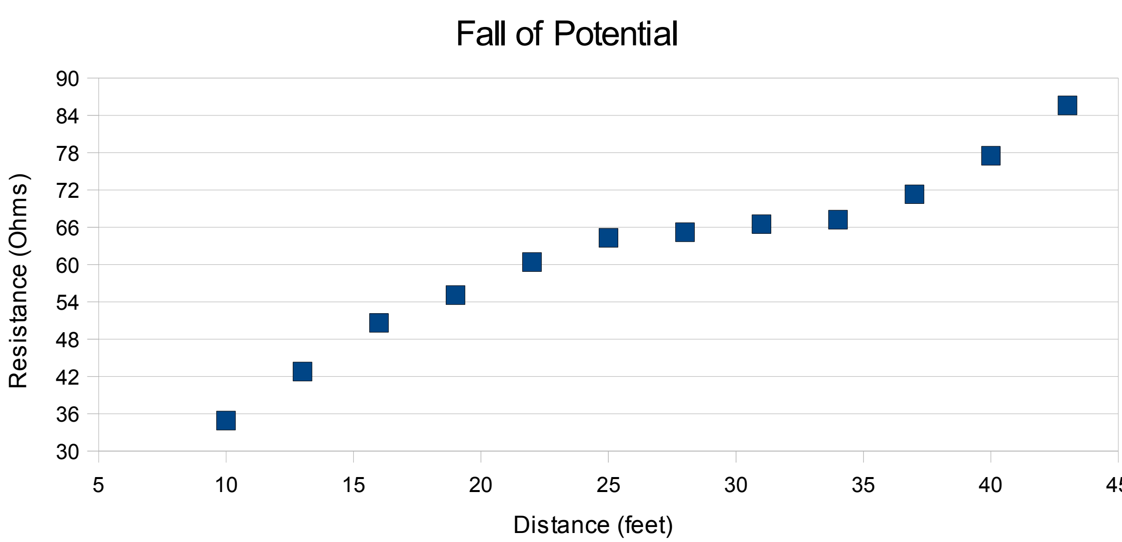
The meter has four ports: E1, P1, E2 and P2. A current flow is established between the electrode under test and a reference electrode. The electrode under test is connected to E1 & P1. The reference electrode is connected to E2.



Test Equipment Setup for a Fall of Potential Test.

A third electrode is connected to P2. This electrode is moved to various locations between the E1 and E2 electrodes. Resistance readings from the meter and percent of distance between E1 & E2 are recorded and plotted.

If the test is successful then a curve similar to the one shown below will be obtained. Note the flattening of the curve near the 62% point (31 feet in this example). If this flattening is not observed then the distance between the Test and Reference electrodes should be increased. The resistance at the 62% point is the ground system resistance.



The effectiveness of a ground system can be measured with a ground resistivity meter using the Fall of Potential method. The CEM DT-5300 is an inexpensive Earth Resistance Tester available on-line for under $200.

Before making a measurement, disconnect the ground system under test from the power company's neutral. This is typically done at the meter head. Be sure to reconnect the system after the test!

The National Electric Code calls for a resistance to ground of 25-Ohms. In installations with sensitive electronic equipment many experts recommend a resistance of 5-Ohms or less.

Conductivity enhancing backfill, such as coke breeze, can significantly lower a system's resistivity.

In cases of very poor soil chemical electrodes may be necessary. Chemical electrodes need periodic "recharging."

The tops of the vertical electrodes should be accessible for inspection. An underground valve box, e.g. Home Depot SKU # 164860, can be used to protect the end of the electrode.

Vertical electrodes should be spaced apart by at least twice their buried length.

Ground systems should be measured and inspected periodically.

- If a lightning strike has turned the soil surrounding an electrode into glass the electrode will be loose. A replacement electrode should be installed in a nearby location.
- Mechanical, e.g. bolted or crimped, connections should be inspected and tightened annually.
- If a buried connection will be inaccessible use a non-mechanical bonding method such as a CadWeld or silver solder using stabilized methylacetylene-propadiene (MAPP) gas.