Station Grounding

Station Grounding

Proper station grounding is important for a number of reasons:

- Protection from direct lightning strikes
- Protection from nearby lightning strikes
- Proper antenna performance
- RF safety in your shack or for portable operation

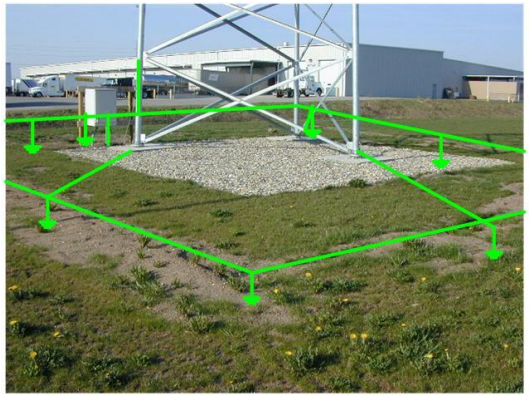
Lightning

- A typical lightning strike can produce a current of thousands of amperes.
- This current produces a large magnetic field that can couple into nearby conductors and produce large voltages.
- A large portion of the energy of a lightning strike is in the low frequency RF range.

Tower Lightning Protection

- There is no guaranteed protection against a direct lightning hit!
- We can however make our installation a less attractive target to lightning.
- We can also take care of any secondary surges and static build up that can destroy equipment and give potentially lethal shocks.

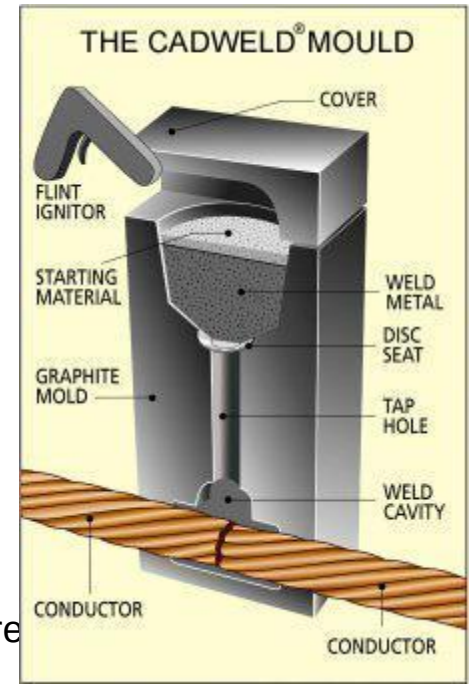
Tower Lightning Protection

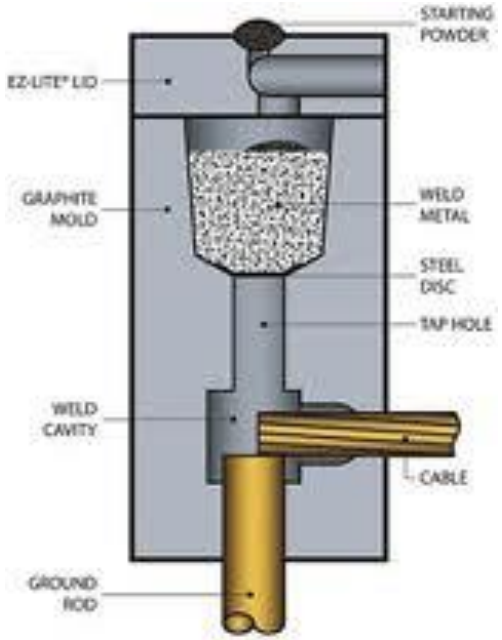


- Use current division to control the dissipation of lightning strike energy on an antenna tower grounding system through multiple paths.
- Connections to the tower and ground are clamped mechanically. Do not solder lugs on the ground cables.
- Use a circle (or square) of burred ground rods and bare ground wire. Clamp all connections or use thermite cups to weld the ground rods to the ground wire.

Connecting to Ground Rods

- When connecting buried ground wires to Multiple ground rods they should be attached using exothermic welding if possible





CADWELD

CADWELD® Welded Electrical Connections

Molds & Weld Metal

EXOLON – Low Emission

ONE-SHOT – Disposable Molds

Lugs, Tools

& Accessories

Information on CADWELD products can be found at:

http://www.erico.com/public/library/fep/LT0355.pdf

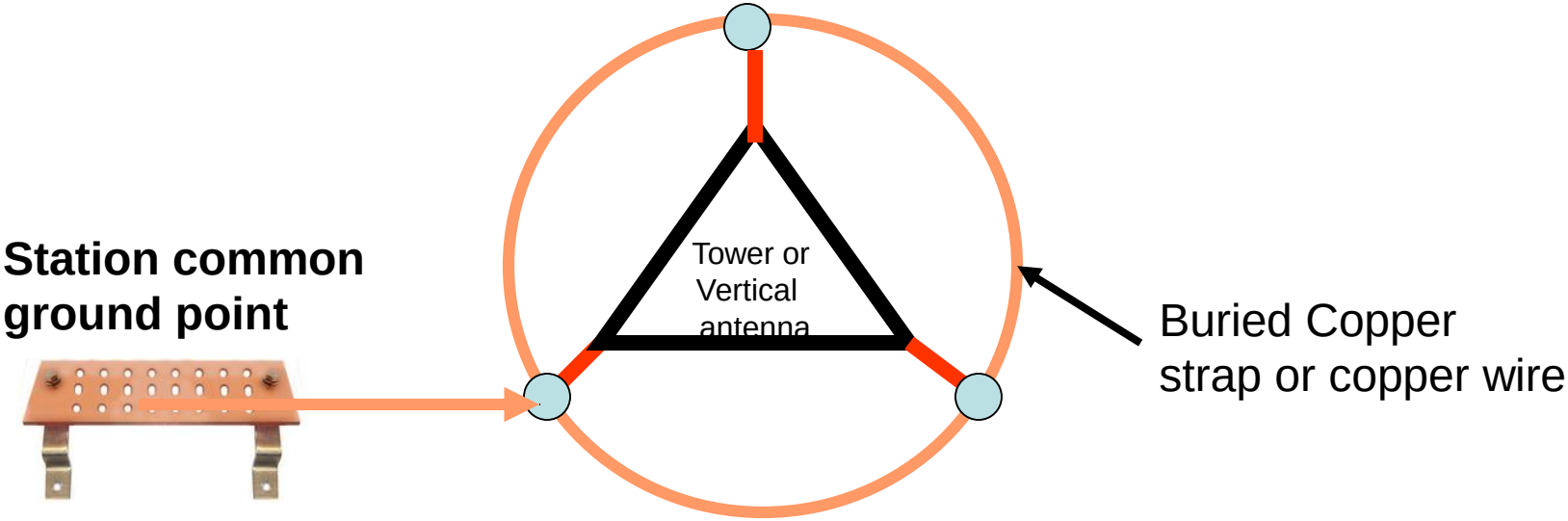
Tower Lightning Protection

- All grounds for the installation should be bonded together at the ground. **NEVER** daisy chain grounds. All connections from devices should go directly to the closest ground point. Use eight foot copper clad ground rods for all. Bond the rods with single ott solid bare copper wire.

- Run bare copper between the separate ground rods to form a ground system. The bare copper provides additional surface contact area for the ground system and should be buried underground, but does not need to be deep.

Tower Lightning Protection

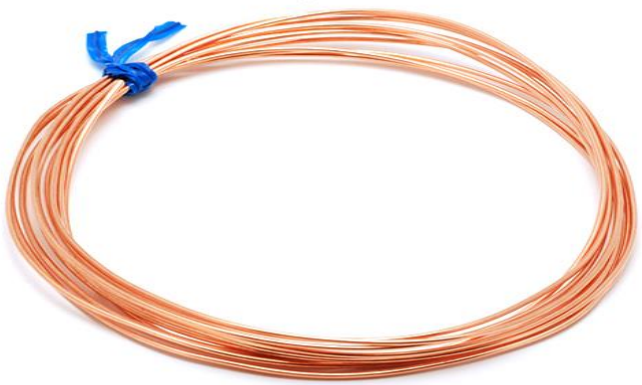
- All grounds for the installation should be bonded together in a closed loop.
- Multiple grounds from the tower legs should all go directly to the closest ground point.



Tower Lightning Protection

- Run buried bare copper wire or Copper strap between separate tower ground rods.

- The bare copper provides additional surface contact area for the ground system.



Tower Lightning Protection

- With thousands of amperes flowing during a lightning strike multiple ground points will yield large potential differences between the ground points

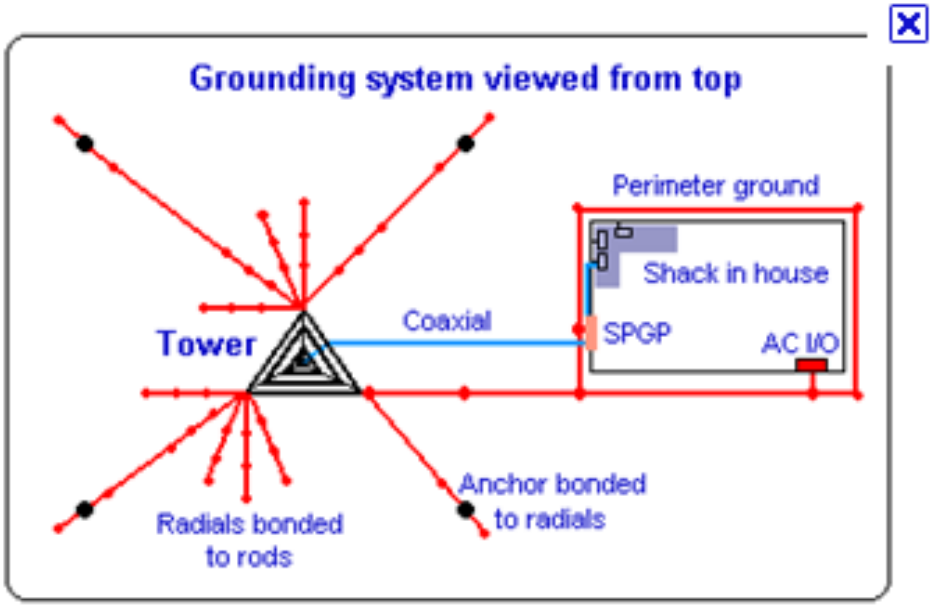
- Use buried heavy gauge bare copper wire or better yet copper strap to connect to the ground rod(s).

- Copper strap available from georgiacopper.com

Single Point Ground

- If possible the station ground and utility ground rods should be tied together with buried bare copper wire ground connection around the entire perimeter of the shack.

- Additional bare copper ground radials can further improve the dissipation of current from a lightning strike.



Tower Lightning Protection

The ground system should be 10 ohms or less. The following table gives the resistivity of different types of soil per cm.

Soil Resistivity (Ohm-cm)

- **Surface soils, loam, etc. 100 Ω - 5,000 Ω**
- **Clay 200 Ω - 10,000 Ω**
- **Sand and gravel 5,000 Ω - 100,000 Ω**
- **Surface limestone 10,000 Ω - 1,000,000 Ω**
- **Lime stones 500 Ω - 400,000 Ω**
- **Shale 500 Ω - 10,000 Ω**
- **Sandstone 2,000 Ω - 200,000 Ω**
- **Granites, basalts, etc. 100,000 Ω**
- **Slates, etc. 1,000 Ω - 10,000 Ω**

Tower Lightning Protection

- The resistivity of the soil is also influenced by temperature. The resistivity of sandy loam, containing 15.2% moisture, as the temperature changes from +20º to -15ºC. In this temperature range the resistivity varies from 7200 to 330,000 ohm-centimeters

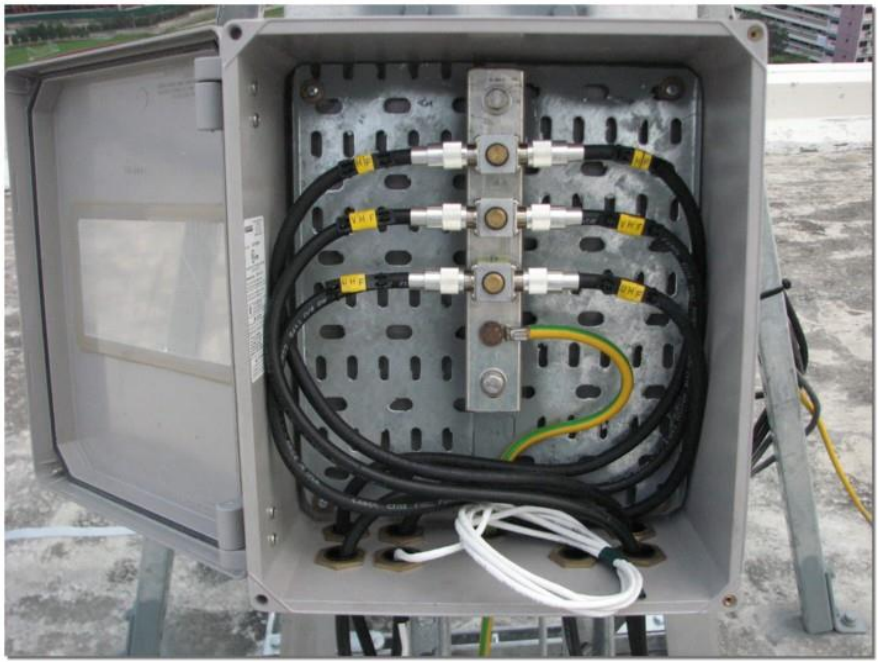
- Soil resistivity is directly related to moisture content and temperature. Therefore it is reasonable to assume that the resistance of any grounding system will vary throughout the different seasons of the year.

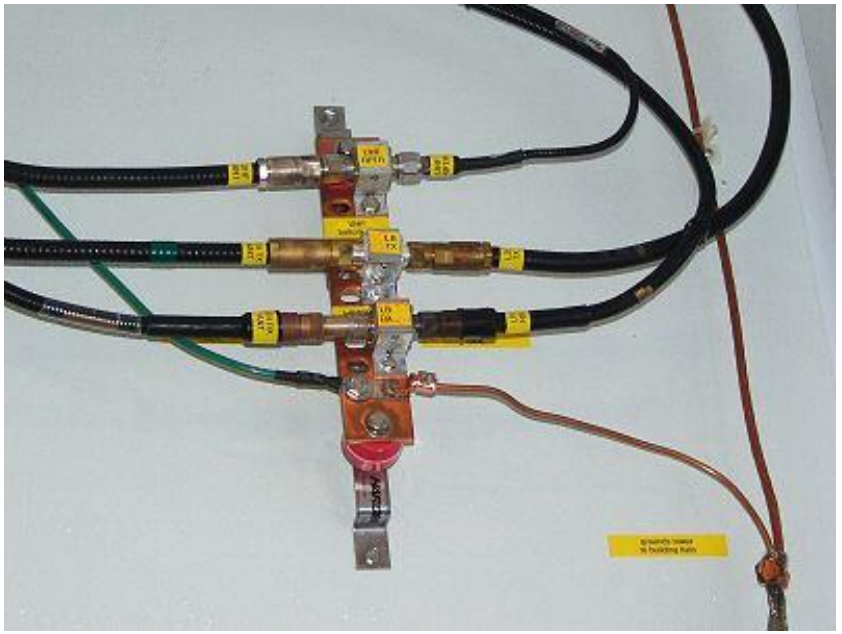
Proper Tower Grounding

- Coax cable shields should be grounded to the top of the tower and at the base where the coax makes a 90° turn to enter the shack or go underground. This is a parallel resistive path to the tower itself.

Proper Tower Grounding

- At the base of the tower install lightning arrestors at the common ground plate for every antenna.





Rotor Cable Protection

- Rotor cables can also carry direct and induced lightning strike voltage into your shack.
- MOV's (Metal Oxide Varistor) surge protectors should be installed from each rotor control line to ground.

Rotor Cable Protection

- The principal "active" element of a MOV Surge Arrester is a metal oxide varistor. At working voltage only a minimum current flows at less than 1 mA.

- Any voltage increase causes a large increase of current flowing through the varistor, leading in turn to immediate limitation of further voltage increase on arrester terminals.

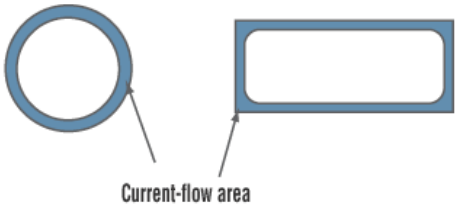
- When the over voltage disappears, the arrester immediately returns to its basic low current operation

Lightning Dissipation

- Buried ground systems dissipate the lightning better than surface or raised ground systems.

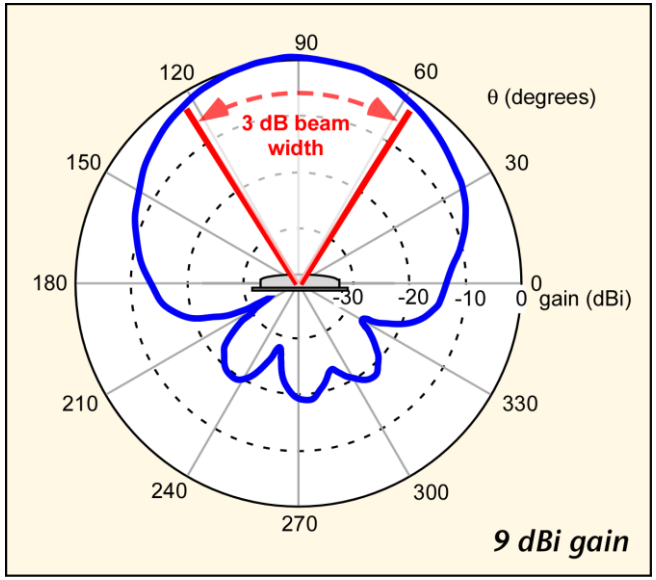
- Since the energy is low frequency RF it exhibits skin effect in the conductor, that is most current flows on the skin or surface of the conductors.

- Copper strap would work better than wire because it has more surface area for the current to flow.



Station Grounding

GND



For Safety

For Performance

AD7FO

Rev. 2.0

Station Grounding

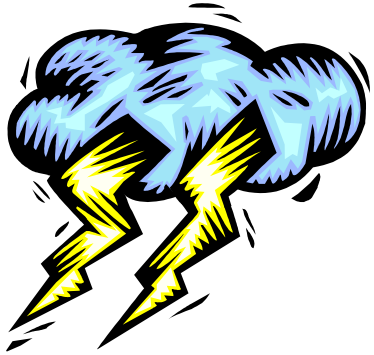
- Proper grounding is a very important aspect of any radio installation.

- There are two major criteria we need to consider when doing the planning for this installation.
  - Safety to persons and property and your gear from a close or direct lightning strike.
  - Providing the best performance from your antenna system and preventing RF voltages from being present on your equipment when transmitting.

Safety Grounding

- The first and primary reason has to be safety, both for ourselves as the operator who will be seated at the controls, but also for our equipment and possibly the structure....probably your home.

Lightning protection



- Power lines. phone lines, cable TV, your antennas, and coaxial cables and rotor cables are targets for lighting.

- They can guide lightning into your shack and your home.

- Protection needs to be provided to bypass lightning induced voltages and currents to earth ground where they enter the building.

Safety Grounding

- The primary rule for surviving a lightning strike is to have all of your equipment connected to a single low impedance ground system.

- This includes protection devices for the antenna support (Pole, Tower, cabling, Etc.) and all your station input and output (Coax, rotor, AC power, telephone and cable TV).

Grounding in the shack

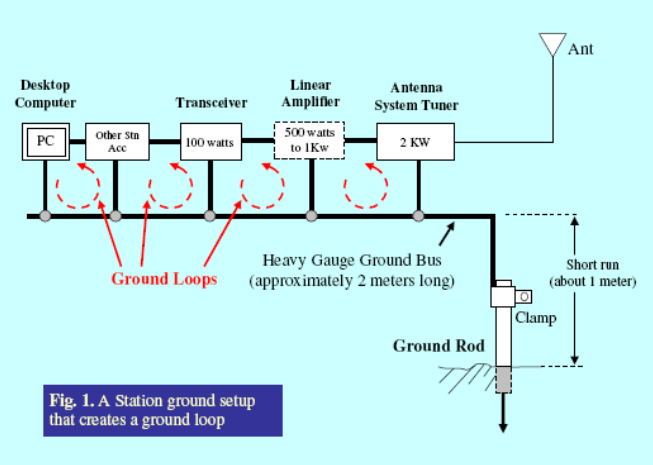
- It is recommended to have a short low inductance single connection point for the equipment in your shack connected to the outside ground network.

- This single point ground should be located where the outside ground enters the shack.

Grounding in the Shack

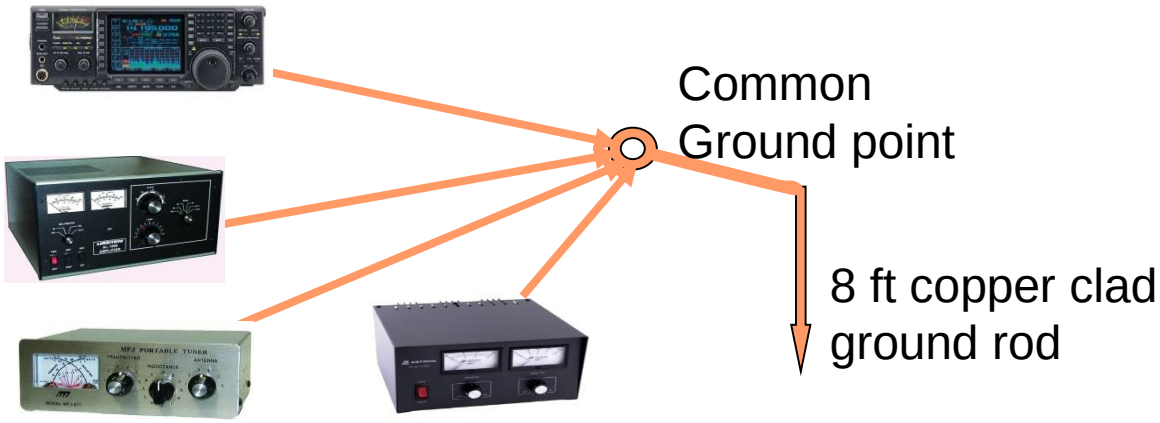
- Do not daisy chain (serialy connect) your equipment to a ground wire. Connect them all as close as you can to a single point ground.

- This prevent ground loops and voltage potentials between the equipment ground connections.



Ground in the Shack

- Connect your equipment with individual ground wires to a common point (Star Ground).
- Keep ground wires as short as possible to minimize inductive reactance at your operating frequency.

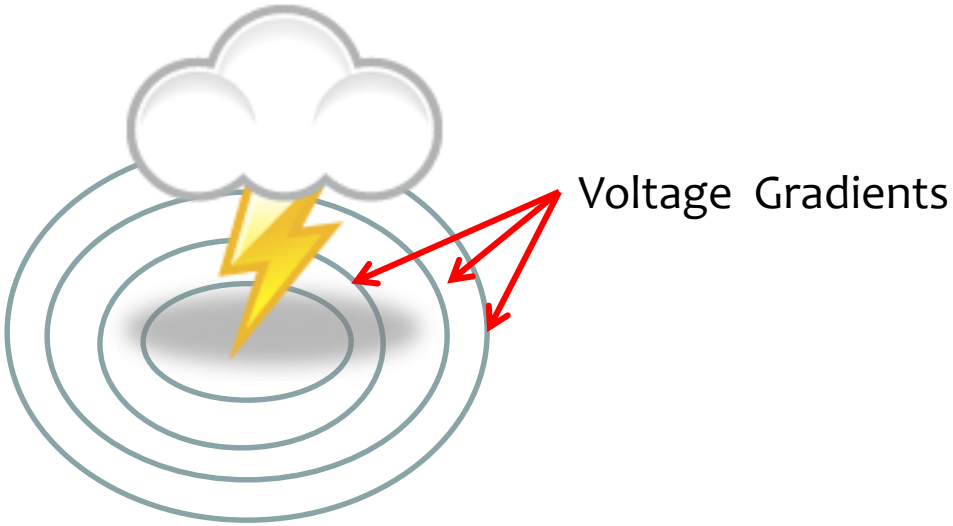


Safety Grounding

- Earth Grounds do not equal Zero Volts with respect to each other or some mystical “absolute” reference point.

- Other nearby ground connections create soil voltage gradients.

- Multiple ground points for equipment places them at differing potentials



Grounding in the shack

- Be sure all equipment is properly grounded to a single point ground point that has a very short path to the external ground system.

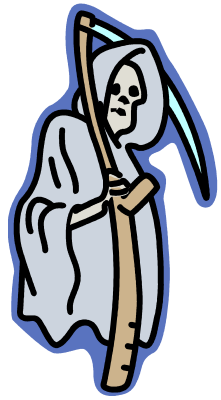
- At higher frequencies the inductance of the ground connection can cause high impedance between the equipment and the external ground.

- An inductive ground lead can become resonant and cause large RF voltages to be present on your equipment.

Grounding in the shack

- Using Ferrite toroid's on the cables (Coax, Rotor, Power feeds to the tower, etic) can prevent RF Current Flow.

How Dangerous is it?

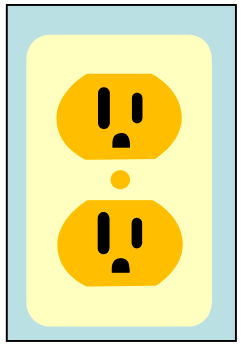


- DC and 60 Hz power are very dangerous.
- The current determines the severity, not the voltage.
  - A 1 ma current causes an unpleasant tingling.
  - 10 ma can cause involuntary muscle contraction and a “death grip” or suffocation if the current flows through the chest.
  - 50 ma through the chest can induce ventricular fibrillation causing brain death minutes.
- Dry skin has high resistance keeping the current low.
- Skin moisture, larger contact area, or increased contact pressure substantially increases the current.

Don’t Get Electrocuted

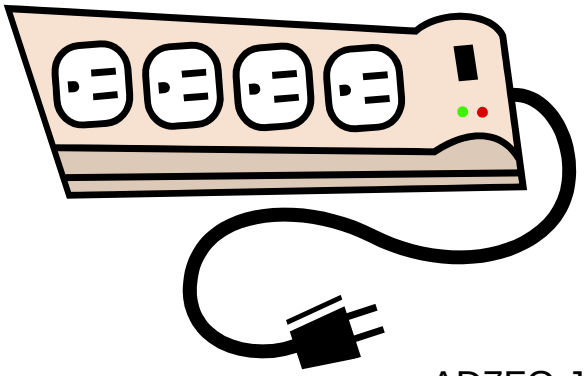
- Be sure your equipment is properly grounded.
- Make sure all antenna coax has another path to ground before entering your shack.
- Make sure all rotor cables have another path to ground before entering your shack.

Safety Grounding

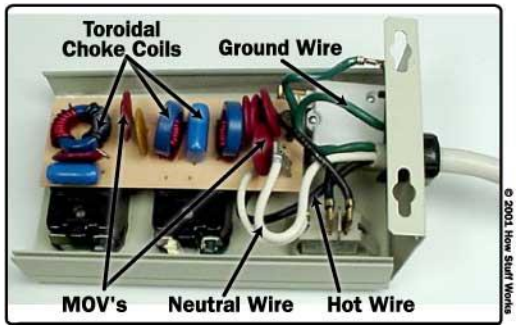


- Always use three wire plugs and outlets to insure hazardous voltages do not appear on your equipment.

- If power strips are used make sure they are three wire type and have surge protection.



Surge Protection



- A direct hit by lightning is not the only danger to your rig.
- A lightning strike a mile away may create short term voltage transient on the power line that can be high enough to damage your rig.
- Surge protection suppressers kicks in when a voltage transient is detected. Think of them as a zener diode that conducts at a predetermined voltage.

Keeping RF out of the shack

- Standing waves on your coax can cause RF voltage to be present on the equipment in your shack.

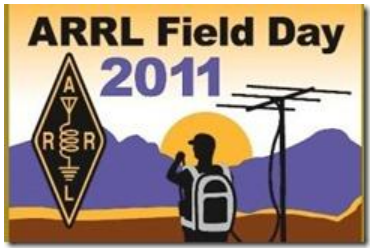
- This voltage travels back on the coax from a mismatch at the antenna. Placing an inductance in the form of a coil of coax, Ferrite beads or wrapping the coax around a ferrite bar or ring. near the antenna can prevent this.

Portable operation

- Field day is a perfect time to try your skill at setting up a portable station.

- Bring a ground rod and use it. Be careful you do not drive into sprinkler systems or underground utilities (phone, cable and commercial power).

- The field day ground rod does not need to be eight feet long. Four feet should suffice.



The Mobile HF ground

- Mobile HF involves some form of vertical antenna (usually with a loading coil to reduce its length).

- The vehicle chassis forms the virtual ground, or counter poise for the antenna.

- For good performance many ground straps must be added to the vehicle to have an effective counter poise and to reduce noise. When transmitting the vehicle may be at a high RF voltage potential. Be sure someone does not contact the vehicle while transmitting

Any Questions