

Grounding & Bonding

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References

- Canadian Electrical Code
- IEEE Emerald Book
- ARRL Grounding and Bonding for the Radio Amateur
- TIA 607-B
- Motorola R56

IEEE is an association of professionals. TIA an association of industries.
Heavily plagiarized from Ward Silver N0AX presentation at Dayton this year.

Overview

- What is ground?
- What is bonding?
- A/C Safety
- Lightning Protection
- RF Management
- Ground System

What is Grounding & Bonding

- Highly controversial
- Many differing opinions
- Needs to be considered as a complete system

What is “Ground”

- Depends on what you are trying to do
- What you are trying to do depends on frequency, voltage, current
- Your safety depends on the right answer
- Your equipment depends on the right answer

Everything depends on everything else.

Are we talking electrical safety, lighting, towers, etc

All depends on frequency, voltage and current

Electrically short at 60hz is much different at 14Mhz

What is “Ground”

- Can be a noun, verb and adjective - at the same time
- Noun - an earth connection (reference potential)
- Verb - an action (connecting to the reference)
- Adjective - a type of connection (ground conductor)

3 Types of Grounds

- A/C Safety Ground
- Lightning Protection Ground
- RF Ground

A/C Safety Ground protects against shock hazards from A/C equipment by providing a safe path for current in case of fault

Lightning Protection Ground keeps all equipment at the same voltage during transients and surges from lightning and dissipates the lightning's charge in earth routing it away from equipment

RF Ground prevents unwanted RF currents and voltages from disrupting normal functions of equipment, ie RFI

What is “Bonding”

- A connection to keep 2 points at the same voltage potential
- Requires the right connecting materials and hardware
- Works in your favour for A/C safety, lightning protection and RF management

What is “Bonding”

- Needs to be low impedance at the frequencies of interest
- Heavy enough to carry expected current
- Sturdy enough to survive

Lightning - #6 or better

In the shack - 20ga strap or #14 wire

Don't use old coax braid. It deteriorates and corrodes reducing the connection.

A/C Safety Ground

- LOCAL CODE IS THE LAW
- Many names - third wire, green wire, equipment ground
- Provides a path to A/C common point for fault currents (shorts, leakage)
- Stabilizes the power voltage during faults or transients

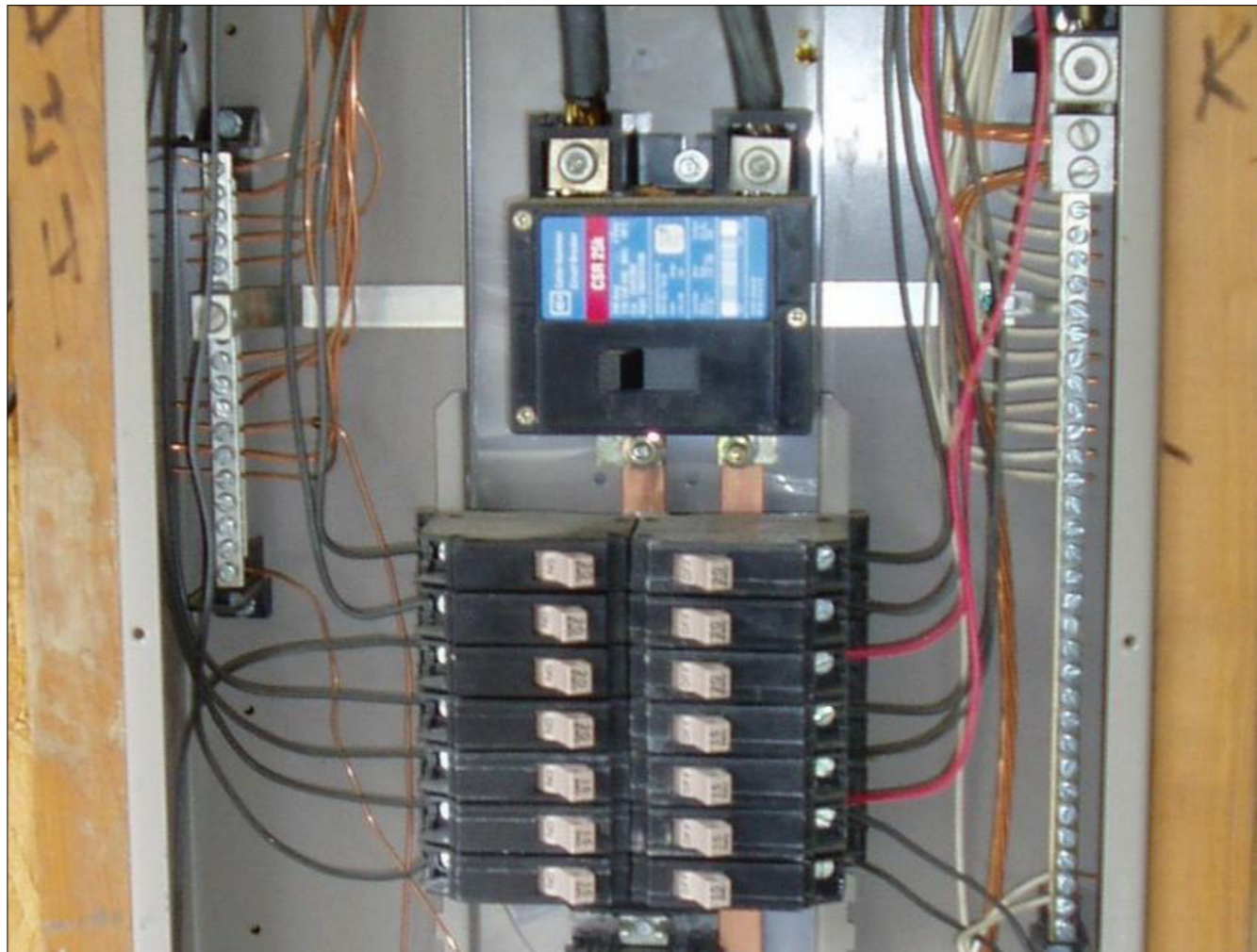
Properly installed 3-wire plugs provide appropriate ground connection. Check it!

Normal 3 light outlet testers cannot test for all fault conditions.

Equipment not connected to 3 wire power can be bonded to equipment that is, or an equipment bonding bus.



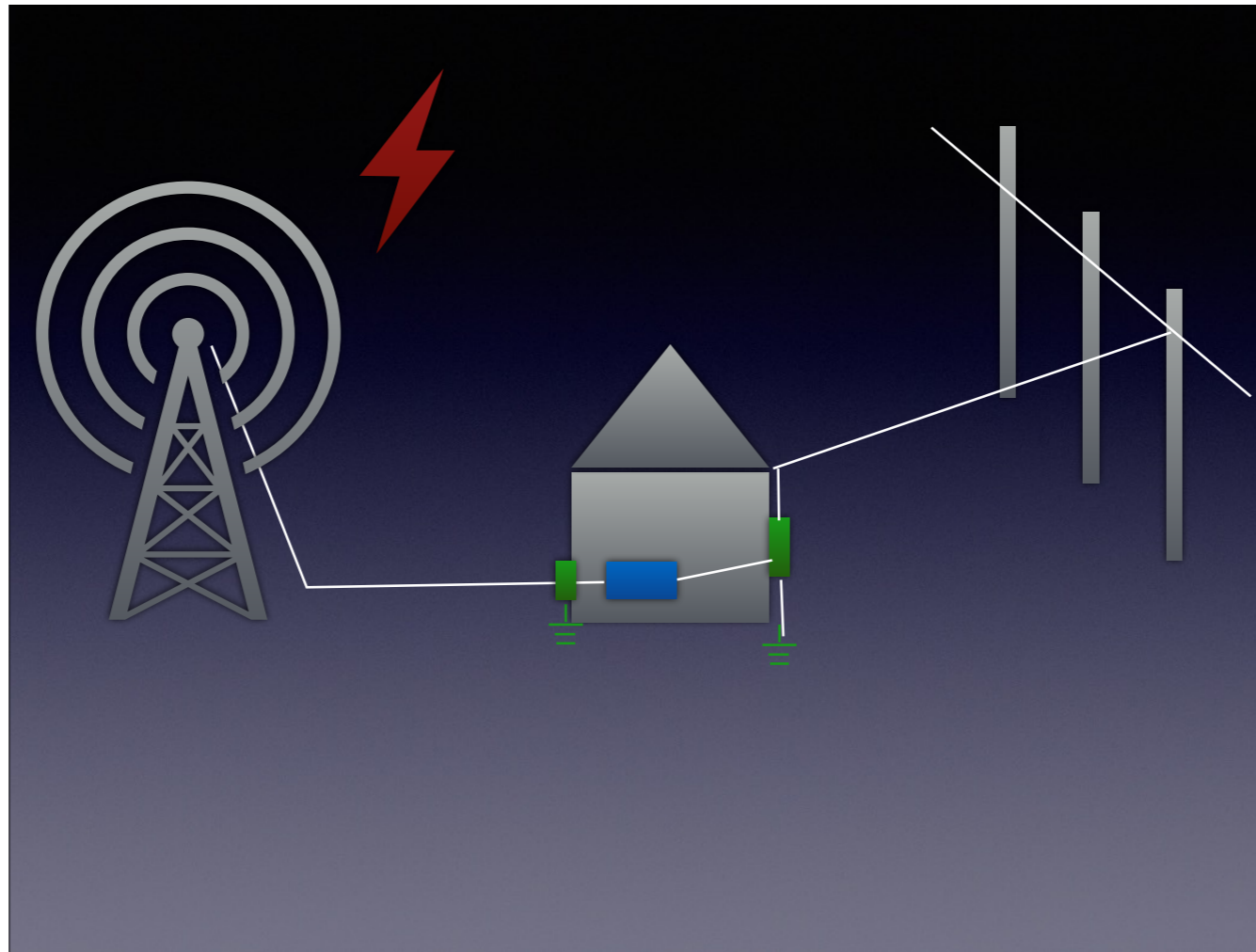
Normal 3 prong outlet testers cannot test for all potential wiring faults. They test at DC and cannot check for impedance at A/C.



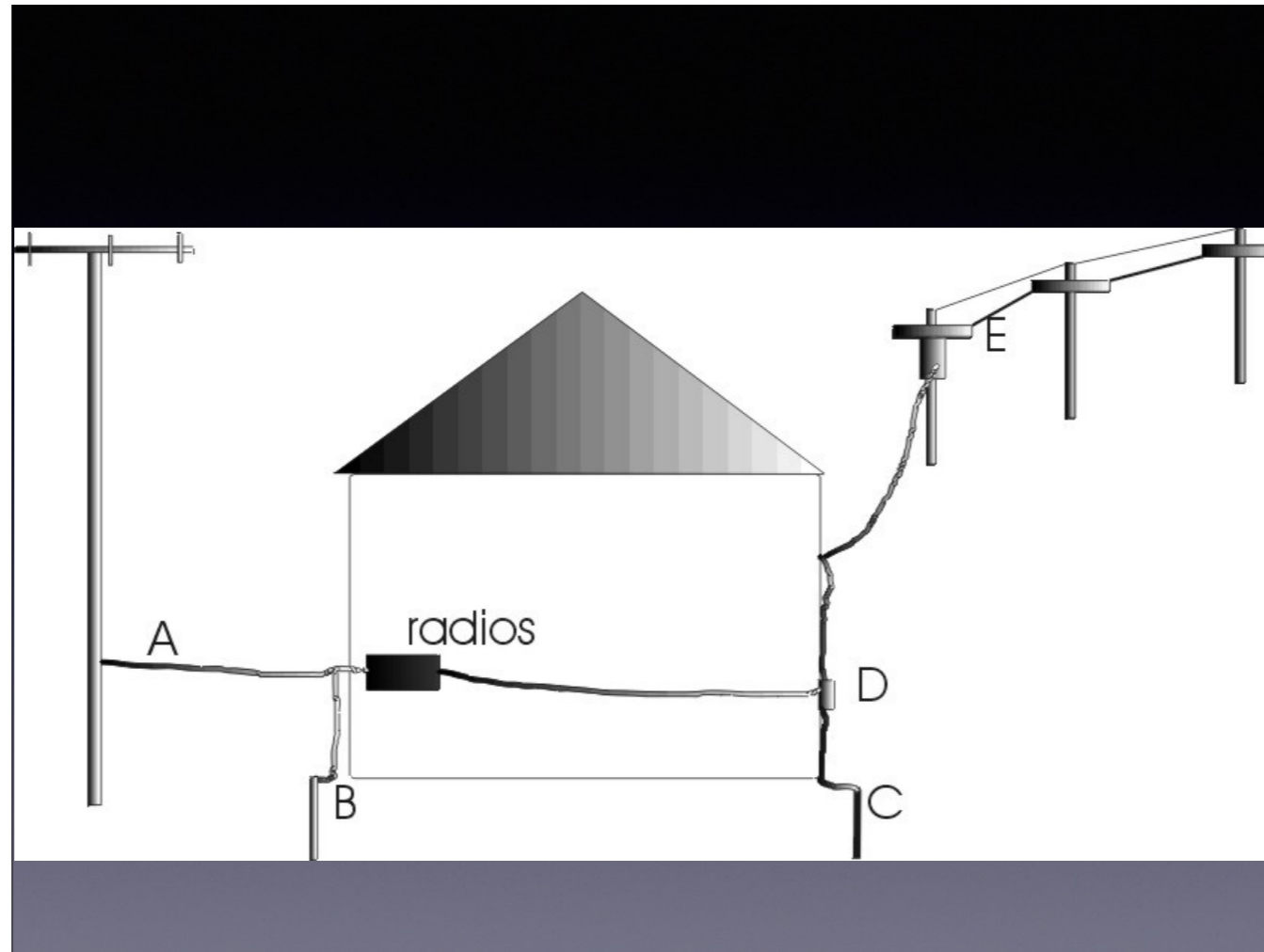
Point out neutral, ground, main bonding jumper, ground cables to electrodes.
No main bonding jumper on sub panels. It needs to be removed.

Lightning Protection

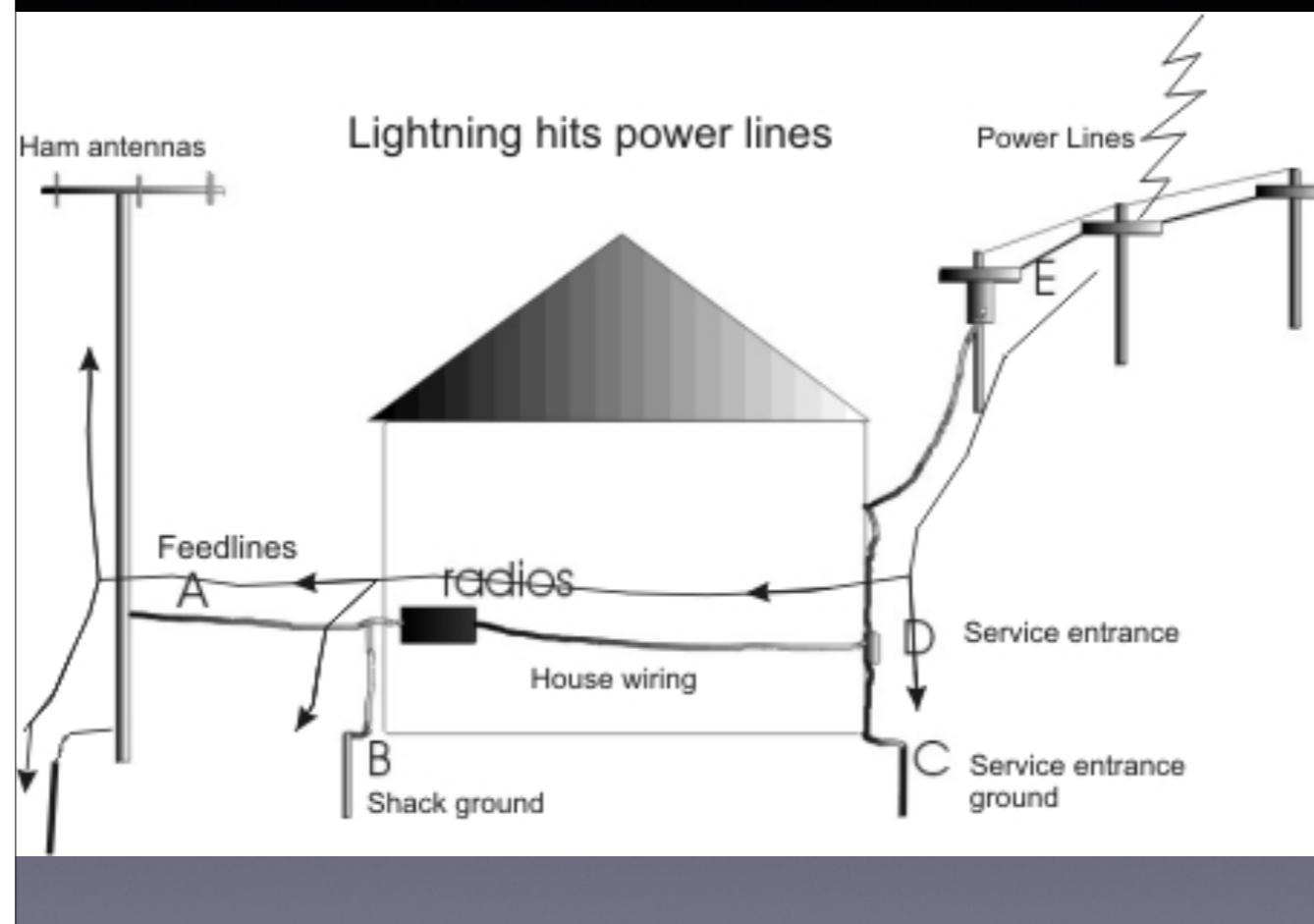
- You can't steer lightning but you can help it make "good decisions"
- Heavy low impedance path to earth
- Paths should be outside your residence
- Don't make it easy for lightning to go through your station on its way to earth

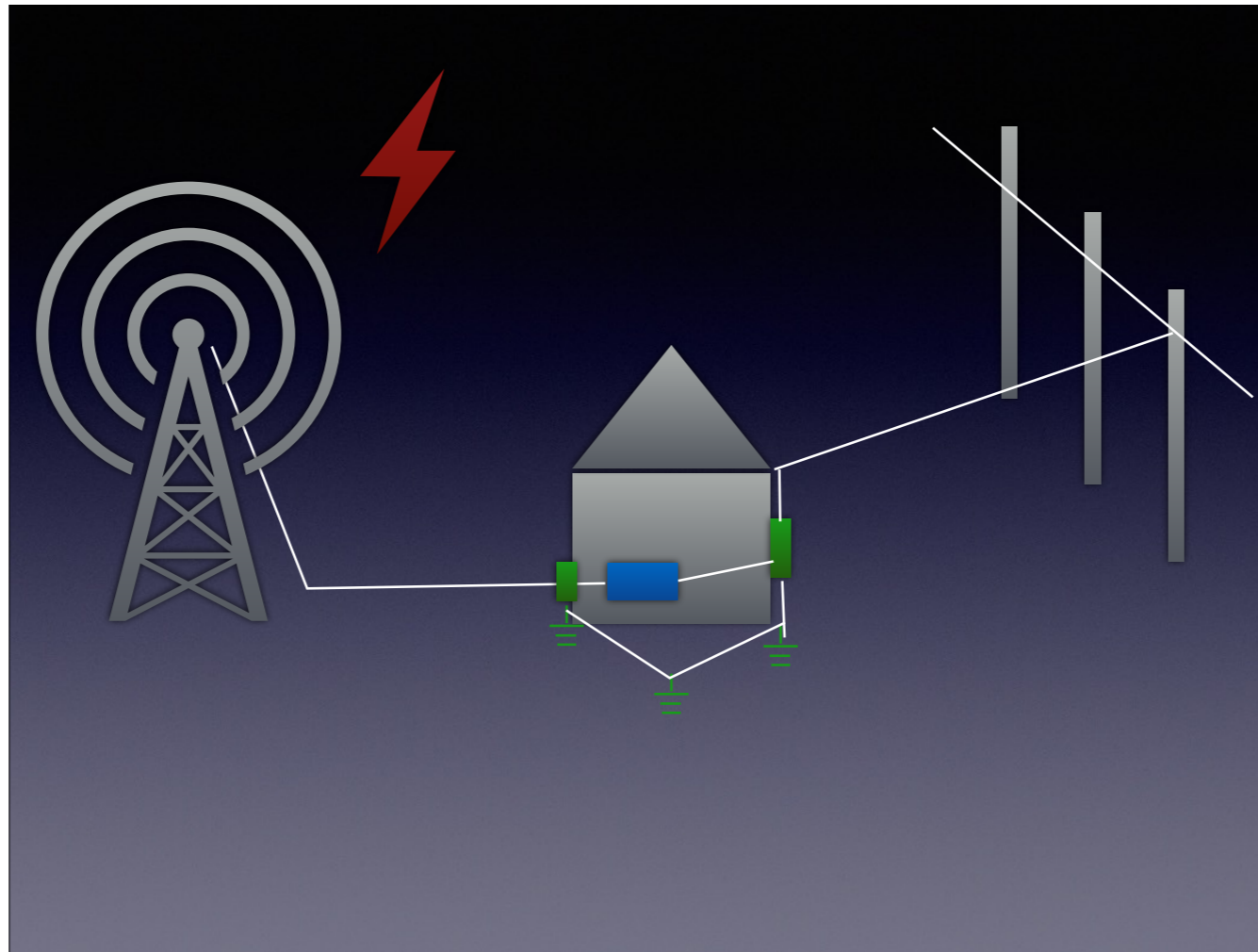


Don't do this! This is the mistake many people make. Not bonding all ground electrodes together.

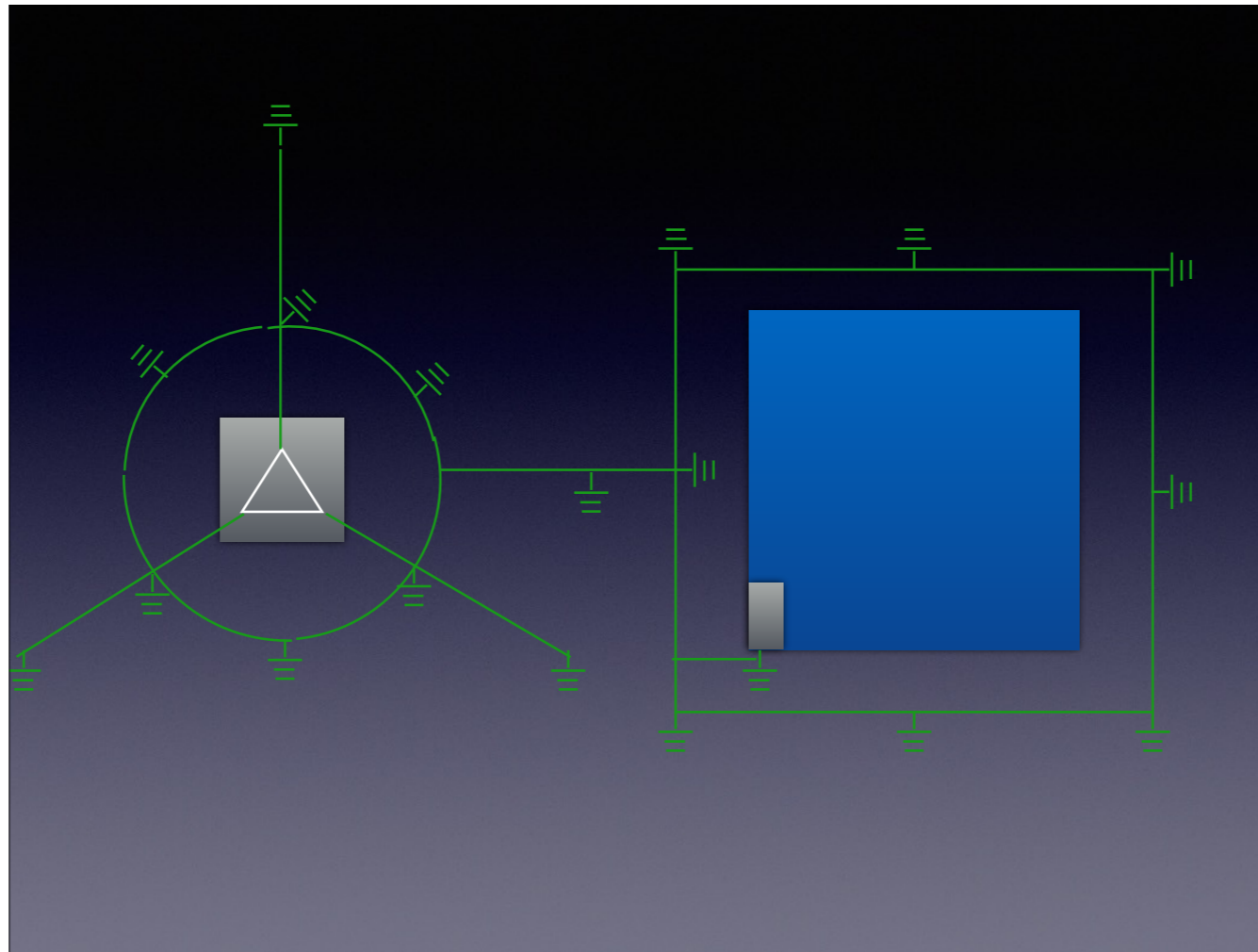


Don't do this! This is the mistake many people make. Not bonding all ground electrodes together.





Do this! All grounding electrodes are bonded together, giving lightning a shorter low impedance path to ground.



This is the text book grounding system. Typical of commercial installations. #4 wire, 10ft ground rods, 30' from tower. At least 12" below surface.
Bond feedlines at top and bottom of tower.
Use spark gaps across insulators.



The coax in picture 1 should be bonded at the top and bottom of the tower.



E-CSGK-150 Shown with option



On the left is a typical connector used to bond the coax shield to the top and bottom of a tower.

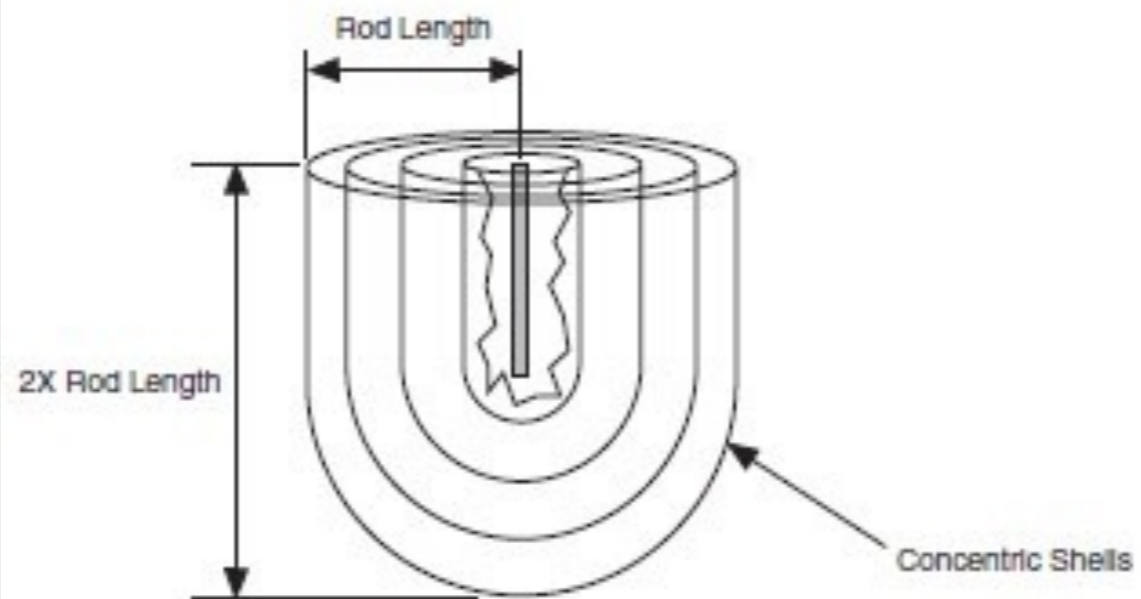
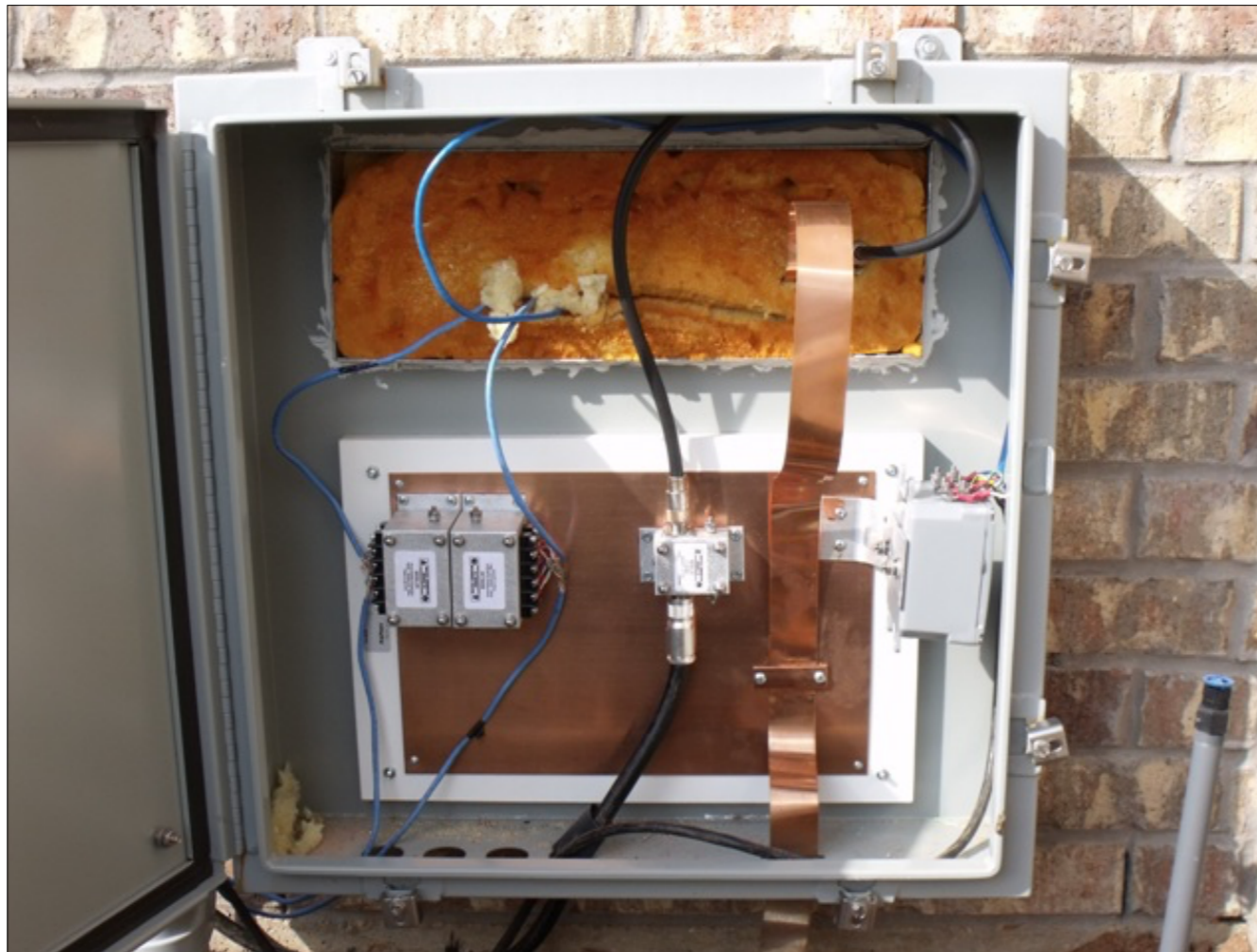


FIGURE 4-5 GROUNDING ELECTRODE SPHERE OF INFLUENCE

Ground rods should be separated by 1.5X their length

Connections should be irreversible, either with exothermic welds or UL listed fasteners. Buried connections need to be permanent or inspectable.

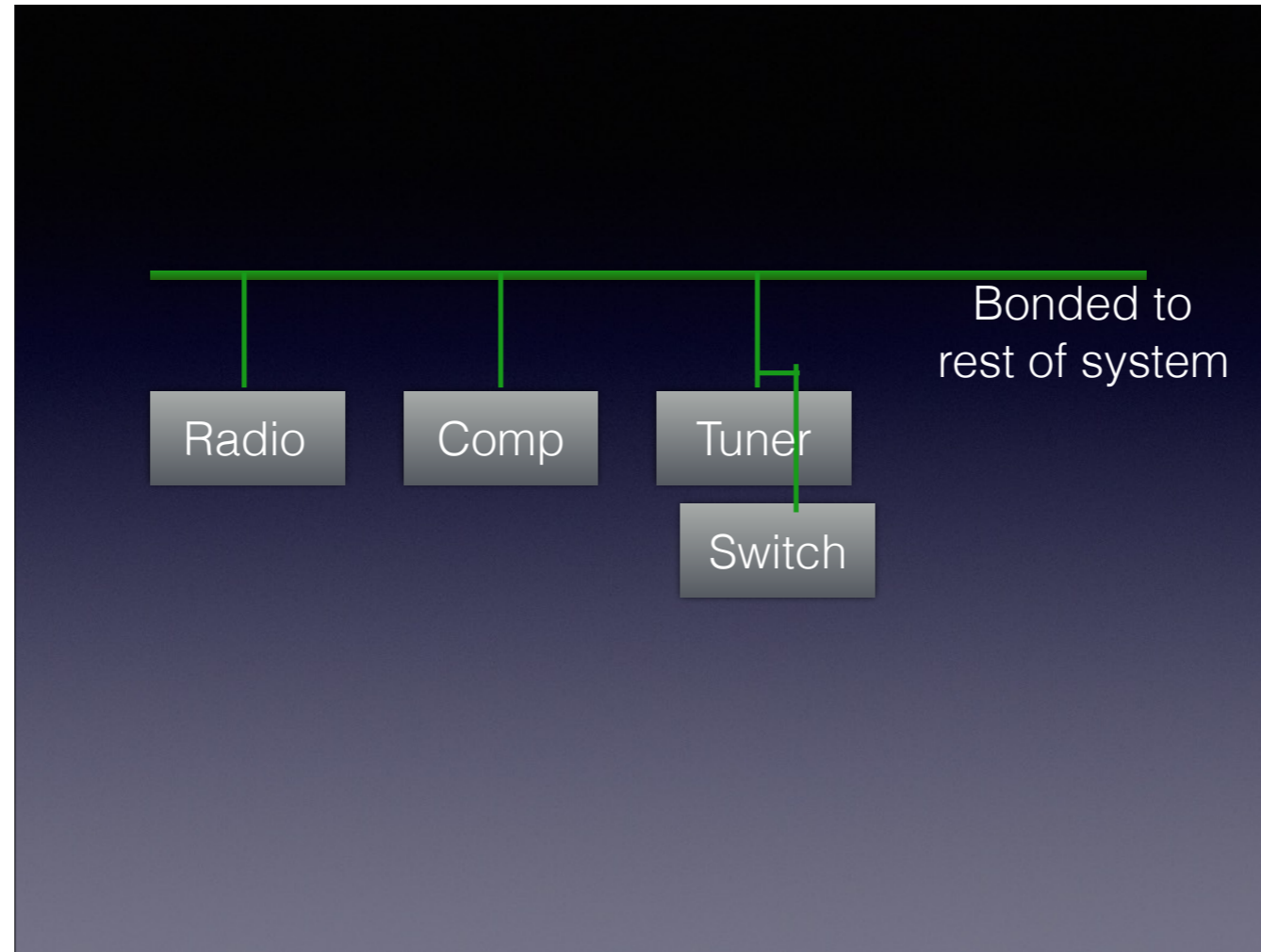
Call before you dig or drive rods in.



Single point ground panel. Everything that comes in should be bonded before entering the residence, as well as have lightning arrestors if available. This includes telephone, satellite tv, cable tv. I believe this is dictated in the electrical code.



Beginning install at my new QTH. Needs a bonding lug with connection to electrical panel ground. Will also have a connection to a grounding electrode that will be part of the ground system for a vertical antenna and eventual tower.



Keep bonding connections as short as possible. Bonding equipment chassis together is often the best way.

Use of braid should be avoided if possible, especially coax braid. Flat strap or 14AWG or larger wire is preferred. Individual strands in braid can corrode, compromising the overall connection.



RF Management

- Everything in the station is an antenna
- Forget about an "RF ground"
- Concentrate instead on bonding
- Equalize voltage to minimize current

Eliminates "hot spots"

Reduced RFI from common-mode current

Reduces sensitivity to physical configuration. No need to rearrange things for different frequencies

Minimizes audio "buzz" and hum

RF Management

- Keep cables short
- Use a bonding bus
- Minimize loop area
- Use an RF ground plane bonded to station ground system
- Run cables along the ground plane



Ground System

- “One system to rule them all”
- All currents flow on all wires

A single, solid ground system made of short, heavy, direct connections satisfies all of the requirements for A/C Safety, Lightning Protection, and RF Management