

# Grounding



“Grounds? We don’t need no stinkin’ grounds” –  
Famous last words of infamous Lineman Ignatz  
“Sparky” Flashover

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# A Ground is a Ground



- ❧ Right?
- ❧ Not Quite so fast Sparky!
- ❧ There are many types of 'grounds':
  - ❧ Earth (Mother) Ground
  - ❧ Circuit Ground
  - ❧ Electrical Safety Ground
  - ❧ Neutral (Danger Will Robinson)
  - ❧ Common
  - ❧ Lightning Protection Ground
  - ❧ And last but not least, RF Ground

# Neutral



- ❧ Neutral is NOT a ground
- ❧ **Neutral** is a circuit conductor that normally carries current, and is supposed to be connected to ground (earth) at the main electrical panel.
- ❧ The degree of connection to ground can be doubtful by the time it gets to the end of your house wiring.
- ❧ NEVER trust a neutral circuit as a ground. Consider it just as 'hot' as the 'hot' wire in the circuit.
- ❧ You can be killed by touching a neutral wire and a real ground at the same time.

# Earth Ground



- ❧ What most people think of as 'ground' (naturally)
- ❧ You stick a wire in the ground and you are grounded, right?
- ❧ Not Quite! For a good 'earth ground' you need a grounding electrode
- ❧ You can use the 'ground' to carry current, but how much and for how long is highly dependent on soil conditions.
- ❧ In the early days of the telegraph, they tried to save money by only running one wire and using ground return. Proved to be unreliable.



# Grounding Electrodes



There are a number of different grounding electrodes in use today. They are the:

1. Standard driven rod
2. Advanced driven rod
3. Grounding plate
4. Ufer (concrete encased electrode)
5. Water pipes
6. Electrolytic electrode.

# Soil Resistivity

## Determines Performance

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- ❧ The copper clad steel driven rod, 8 to 10 feet in length, is now the National Electrical Code standard
- ❧ The copper coating on the rod is NOT for electrical conductivity, it is for corrosion protection of the steel. Actually galvanized rods are even better than copper.
- ❧ Safety Note-A ladder is often required to reach the top of the rod while driving it in, which can become a safety issue. Many falls have resulted from personnel trying to literally 'whack' these rods into the earth.
- ❧ Rocky terrain creates problems as the tips of the rods continue to mushroom. Often, these rods will hit a rock and actually turn back around on themselves and pop back up a few feet away from the installation point.

# My Favorite – The Ufer Ground



- ❧ The Ufer ground is what you got in a house constructed 30-40 years ago.
- ❧ The NEC says now that it is supposed to be a minimum 4 AWG 20' wire encased in at least 2" of concrete.
- ❧ Back then, they connected a ground wire from your electrical panel to a piece of rebar and said you had a Ufer ground.
- ❧ This type of ground was supposed to have been developed for ammunition bunkers.

# Trivia Question



⌘ What is the most common electrical circuit in the world to use 'earth' ground?

⌘ Answer?





# Water Pipes



- ❧ Better than nothing(Even Copper ones)
- ❧ Water pipes provide a poor path to earth for electricity as they can corrode, have electrically isolative barriers (Plastic sections), or be non-metallic pipes. This is why the National Electric Code requires that an additional grounding electrode be installed along with the connection to a water pipe. It is better to think of water pipe as a required metal object that must be bonded to the ground system, rather than thinking of it as an electrode for the ground system.

# Circuit Ground



- ❧ Circuit Ground is the lowest potential point in the power supply of the circuit you are working with.
- ❧ It does not necessarily have anything to do with earth ground, safety ground, signal ground or anything else.
- ❧ Nearly all of the metal in your car is part of the circuit ground of the vehicle.
- ❧ On a circuit board, it is the ground or V- bus.
- ❧ Signal ground and circuit ground don't have to be the same thing (more on this later)

# Electrical Safety Ground



- ❧ This safety ground is intended to reduce the risk of electrocution or major fires caused by short circuits, electrical transients and/or faults.
- ❧ Safety grounds are NOT a good place for RF grounds (more on this later)
- ❧ In home electrical circuits, it often is the green (ground) wire in a three wire circuit. That wire ties back to the main electrical panel. Tool cases are either double insulated or grounded.
- ❧ GFI's detects that the electric current is not balanced between the energized (line) conductor(s) and the return (neutral) conductor. Nothing to do with ground
- ❧ In fact, you can often get dangerous amounts of voltage and current between neutral and ground.
- ❧ GFI's also cannot detect the situation where a human accidentally touches both conductors at the same time, since the flow of current through an expected device, an unexpected route, or a human, are indistinguishable *if the current returns through the expected conductor.*

# Common



- ❧ Common circuit is used all too commonly
- ❧ Make sure you know EXACTLY what someone means by a 'common' ground.
- ❧ It may mean certain points on a circuit are all connected together and may have no relation to any kind of useful 'ground'.

# Lightning Protection Ground

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- ⌘ Really a type of electrical safety ground particularized to protecting against lightning.
- ⌘ Where do you want lightning to go? It is going to find the shortest or easiest path to earth ground. You want to make that path as far away from you, your house and equipment as possible.
- ⌘ If it hits your antenna, you want it to go to ground straight from your antenna, not down your coax to the rig and THEN to ground.



# Lightning Protection (2)



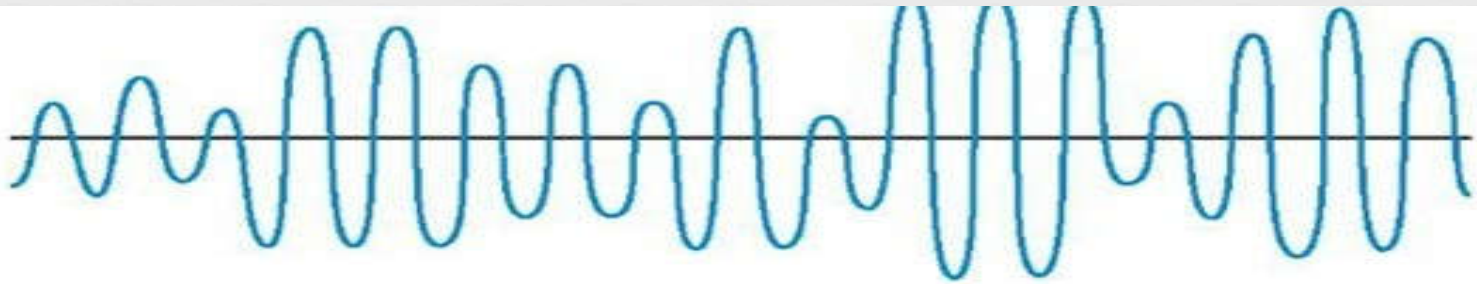
- ❧ You want lightning to go straight into the ground, not down your electrical system or your water pipes to ground.
- ❧ That's why you want lightning protection at the closest point of your antenna/feedline to ground, and for good measure where your feedline goes into your house if it is a ways away from your antenna.
- ❧ Drive ground rods or have other high-quality grounds where you have the lightning arrestors.

# RF Grounds

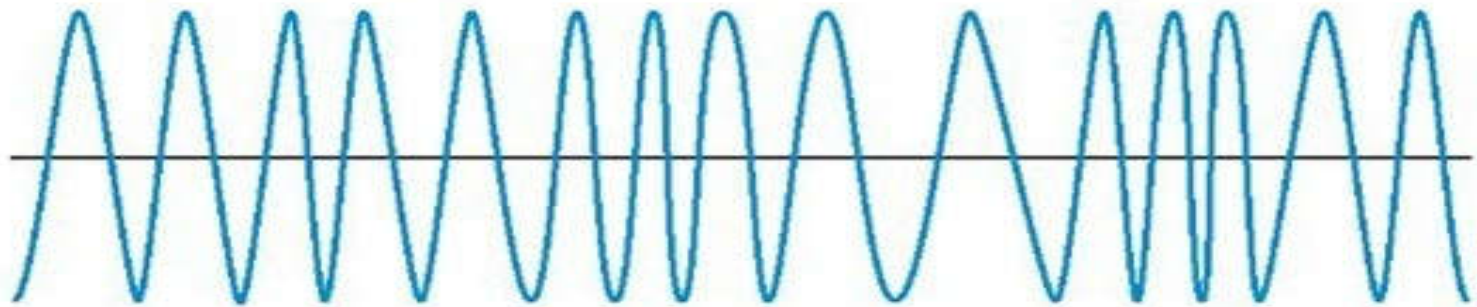


- ⌘ A Horse of a Different Color (More like a unicorn)
- ⌘ Until we started generating RF, we didn't know there was a really big difference.
- ⌘ 60 cycle AC circuits usually don't show big effects
- ⌘ With RF, capacitive and inductive coupling effects become major problems.
- ⌘ Other attributes like 'skin effect' begin to become important
- ⌘ Wavelength and standing waves start dominating

# RF on a Line



AM — Amplitude Modulation



FM — Frequency Modulation

# Effective RF Ground



- ❧ Ensures that the ham's operating position is at a low RF voltage by providing a low-impedance path for unwanted RF
- ❧ Note we said 'impedance' and not 'resistance'
- ❧ Note – a station does NOT require a good earth ground to operate properly. If it did, we would never be able to hear a satellite. A station usually requires a good earth ground to operate safely.
- ❧ RF and earth grounds may be the same thing if done properly.

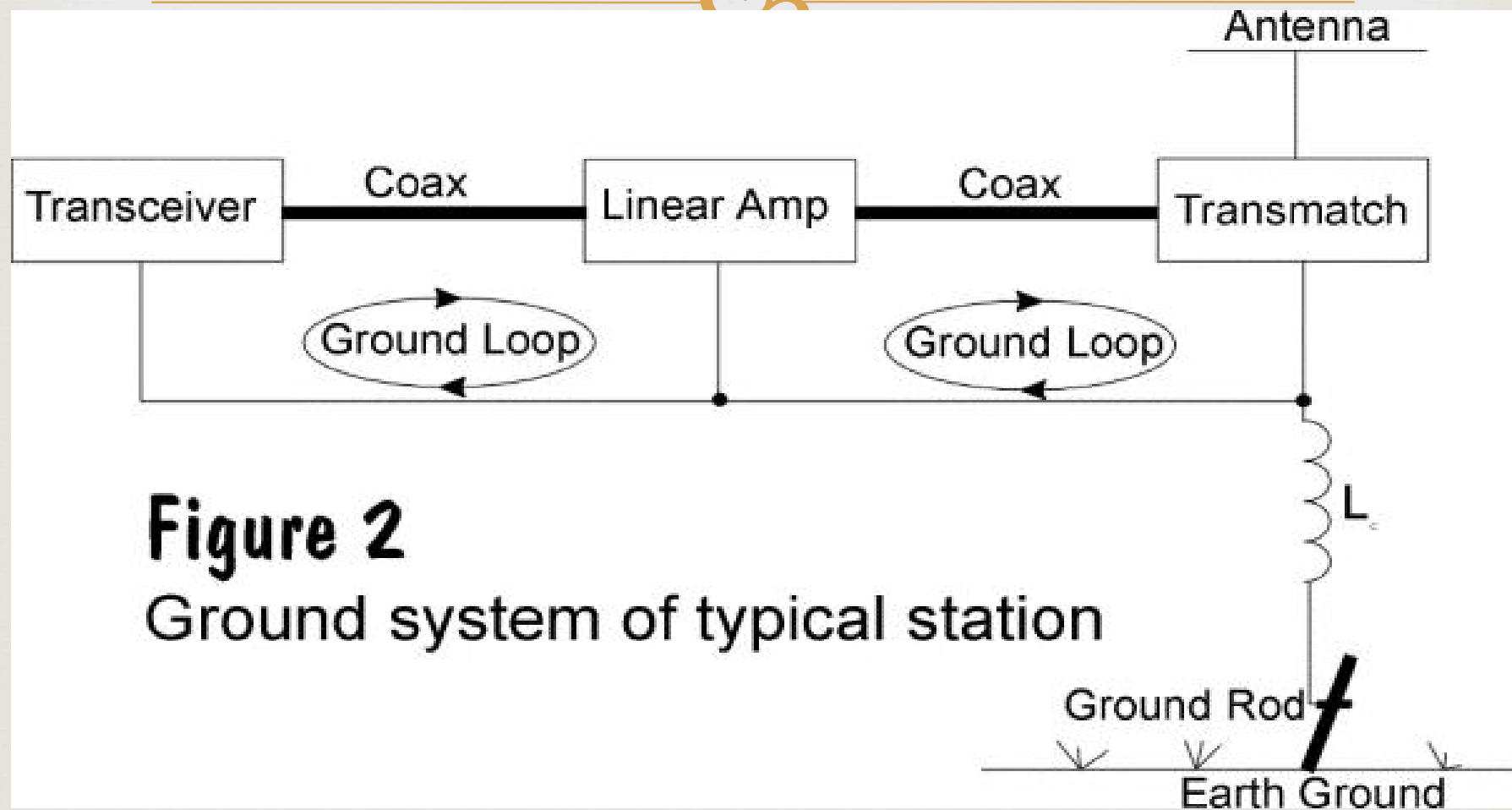
# RF Ground Characteristics



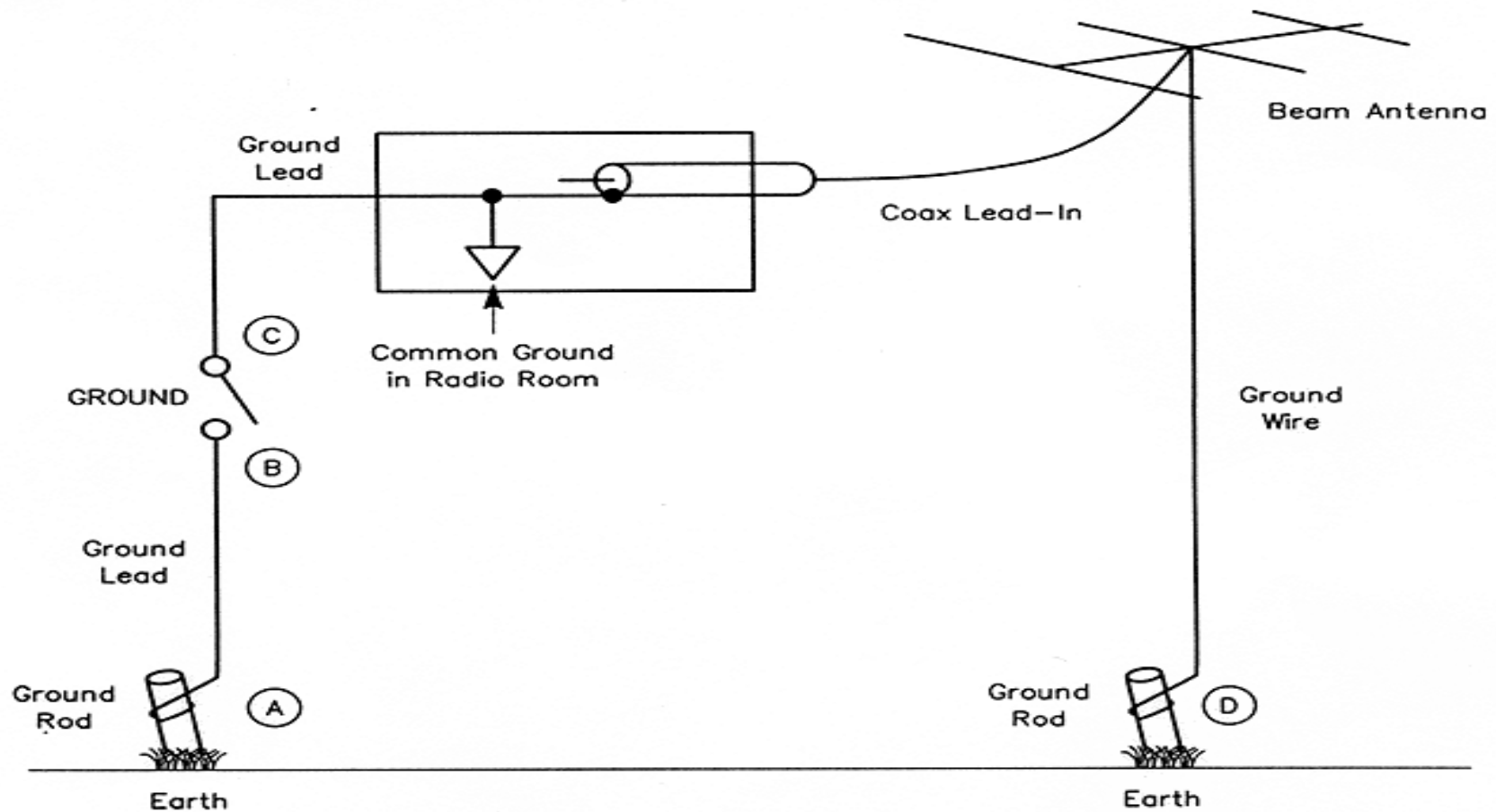
- ❧ As short as possible. Any ground wire has physical length, so it can function as both a connection to ground and an antenna.
- ❧ One ideal situation though is to connect a  $\frac{1}{4}$  wavelength wire to the transmitter ground terminal. Electrically, this puts the transmitter chassis at a low impedance point on the transmitted signal. Not very practical for most situations.
- ❧ The idea of the station ground bus-bar is to have short connections to a common ground point



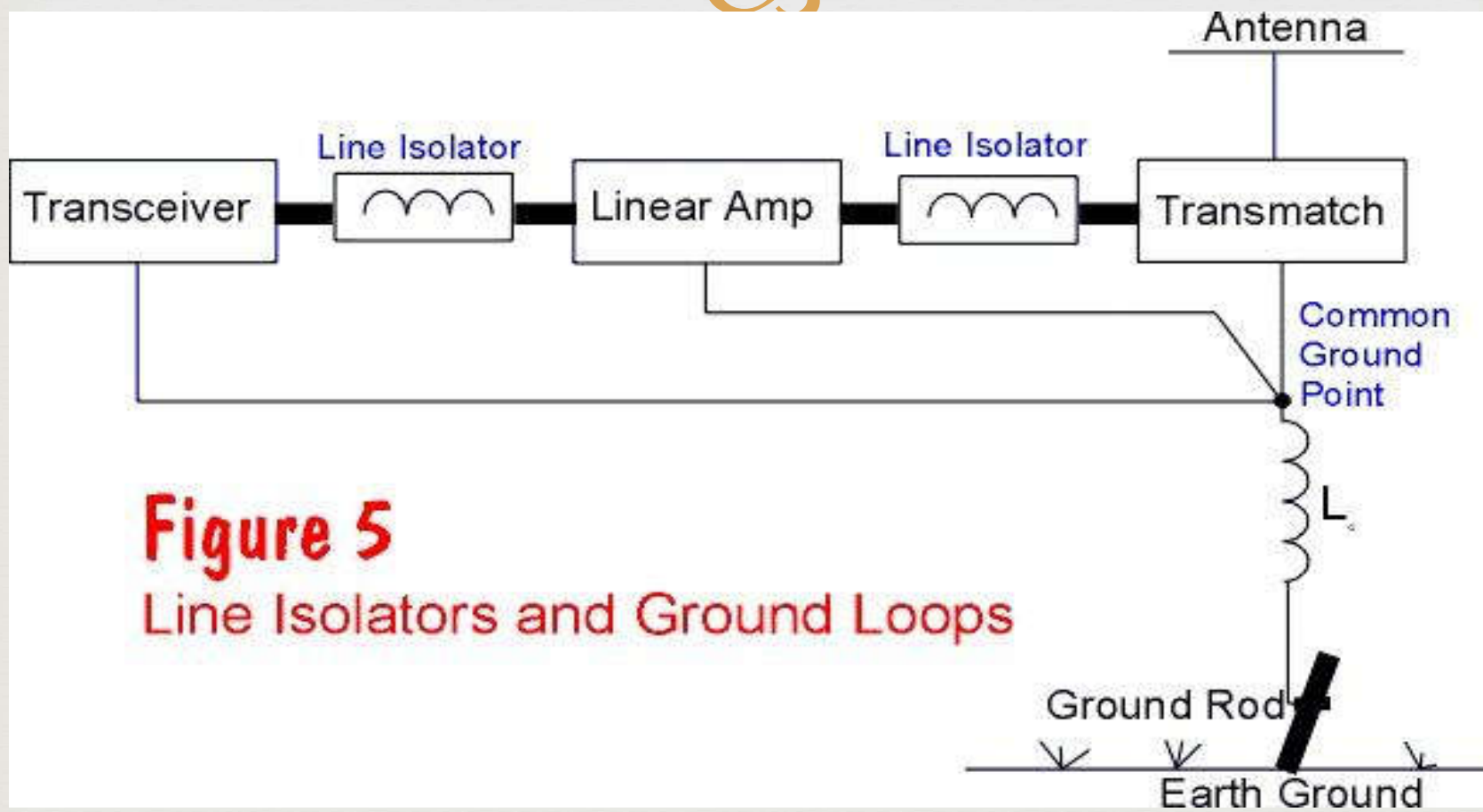
# Ground Loops



# How You Want it to Look



# Another Approach



**Figure 5**

Line Isolators and Ground Loops

# RF Line Isolators



# QUESTIONS??

