

Grounding Issues

Specific to U.S. Electrical Codes &
Home Usage

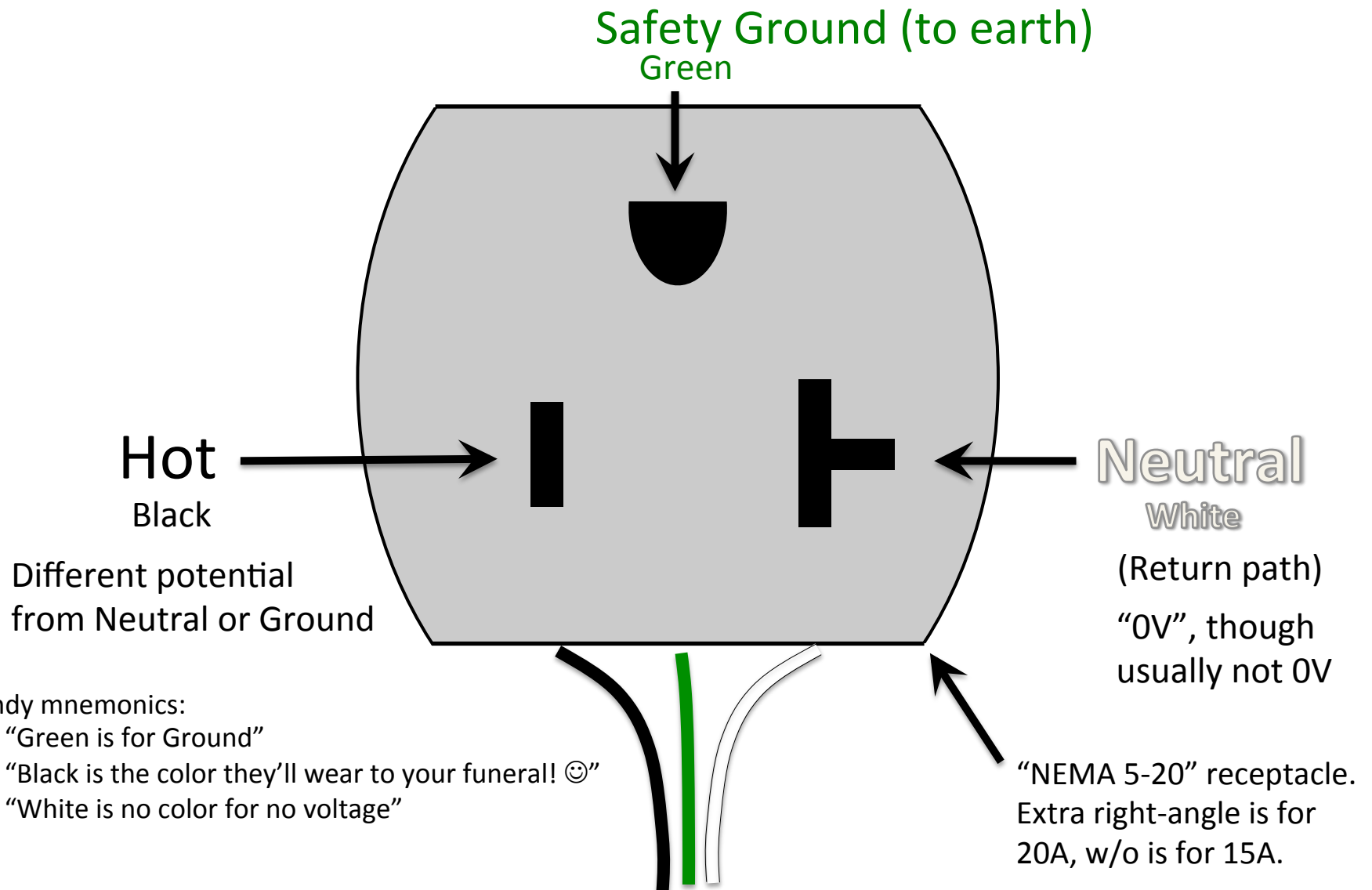
PHY2250

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Electrical Hookups in Home

- Alternating Current system, so no “positive” or “negative”
- 3 wires:
 - “Hot”: potential difference relative to neutral
 - “Neutral”: “0V” line, return back to power company
 - “Ground”: Safety, return line to the earth

Electrical Receptacle



Why's the Plug "Upside Down"?

- So that in case plug is not fully "in" and something else falls on the plug...
- Rather than having the foreign object complete (i.e. short) the circuit between hot & neutral,..
(potentially causing HUGE current & fire hazard),
- The foreign object will just hit Safety Ground, => nothing happens 😊

Ways Current Gets to Ground

- Via pipes in home (older homes)
 - Goes out & links up with buried “ground” wire at utility pole
 - Issues: if pipes get interrupted, need to “bridge”
- Buried pole near house’s breaker box: 8ft long (straight or broken up)

Why Safety Ground?

- To keep chassis of gear from developing a potential relative to earth
- Otherwise, if neutral fails, YOU could complete the circuit by touching the chassis!
- TODO: add pic showing this

So Is Neutral “Safe”?

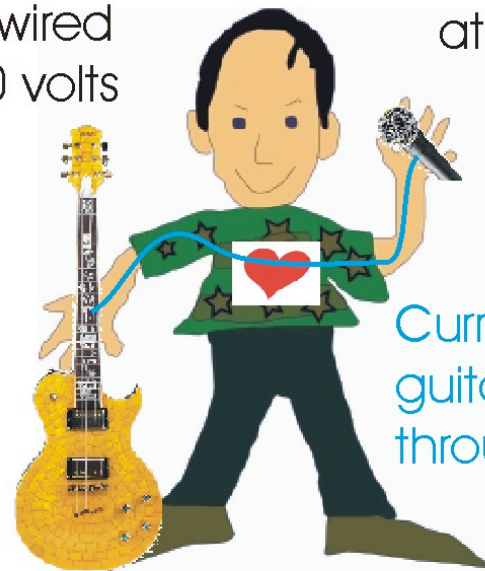
- Not necessarily! The white/neutral wires can in some cases be “energized”. People have been electrocuted from neutral wires!
- Someone (before you) may have done things wrong(ly). Never assume compliance.
- Always shut off the power before any circuit-tampering
- Electrician saying: “Do your grounds first, your neutrals second, and your hots last”

Live Sound Shock Scenario

- Poorly grounded guitar amp = chassis develops a voltage
- Guitar cable (sleeve) connected to chassis
- Strings “grounded” to guitar cable (sleeve)
= strings develop a voltage (!)
- Microphone chassis is “fully” grounded
- Touch strings + touch mic = you complete the circuit (ouch)!

Amp & Guitar
is mis-wired
at 120 volts

Mic is grounded
at zero volts



Current flows from
guitar strings to mic
through your heart

NoShockZone.org

Old Houses = No Safety Ground

- You are allowed to use a Ground Fault Circuit Interrupter (GFCI)
- GFCI compares current in hot & neutral, and shuts off when they're not equal
- Not recommended for serious audio applications
- For audio, best to rewire (part of) house with “real” ground



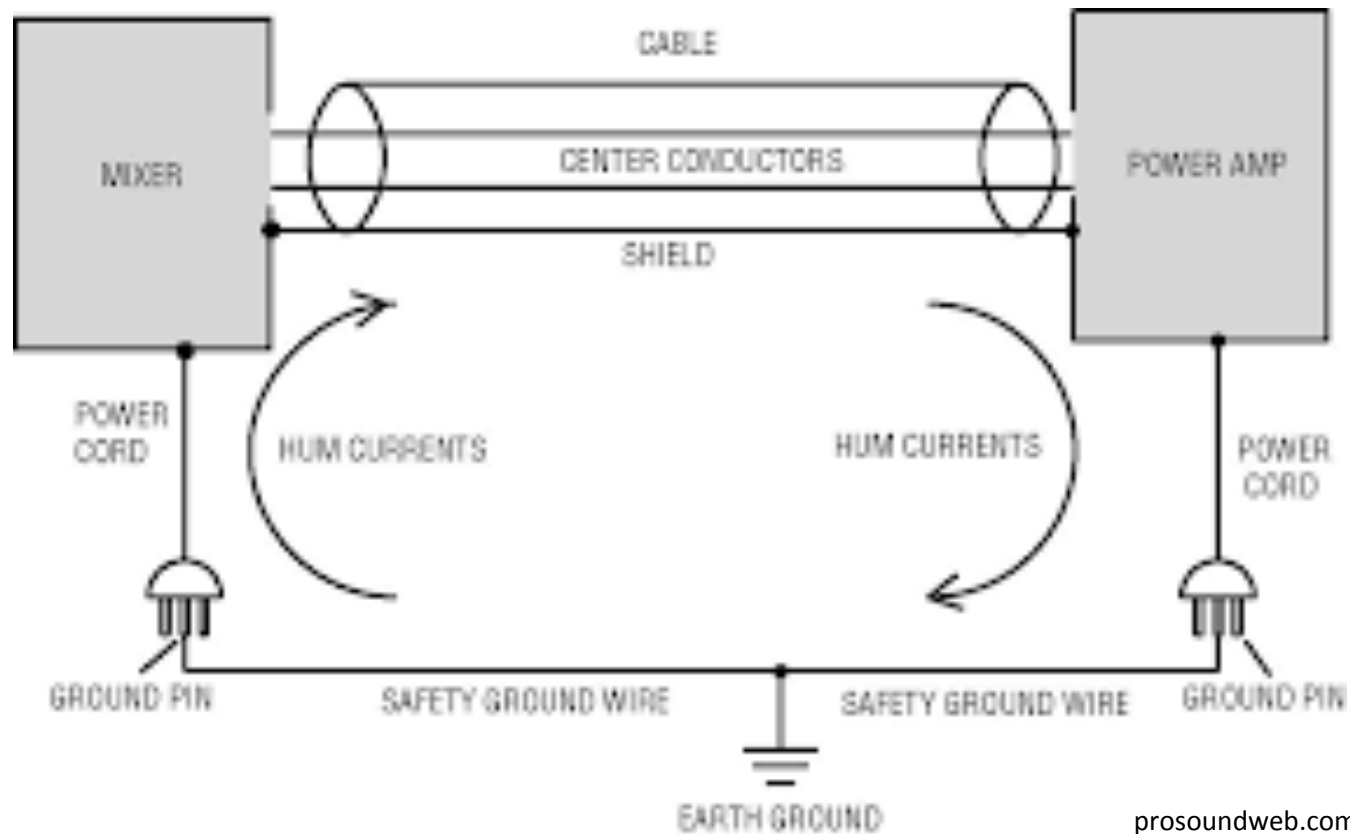
Ground-Related Noise

- “Ground Loop”: Two meanings you’ll find:
 1. Two points are *supposed* to be at same potential, but are *not*, resulting in unwanted current, which may or may not include...
 2. An *physical loop* exists via two devices sharing a ground, and noise is *induced* by intervening electromagnetic fields via Faraday’s Law
- In Practice: Two pieces of gear, connected somehow (e.g. via audio cable), both have their own (separate) paths to ground (e.g. to different outlets)

“Two amps fighting to decide which one is ground” - Dave Hossler, Taylor Guitars
<https://www.youtube.com/watch?v=4YM1iwC6vhg>

Ground Loop, p2

- Faraday's Law: a time-changing magnetic flux induces a voltage (& current) in a loop of wire



What About Cheater Plugs?

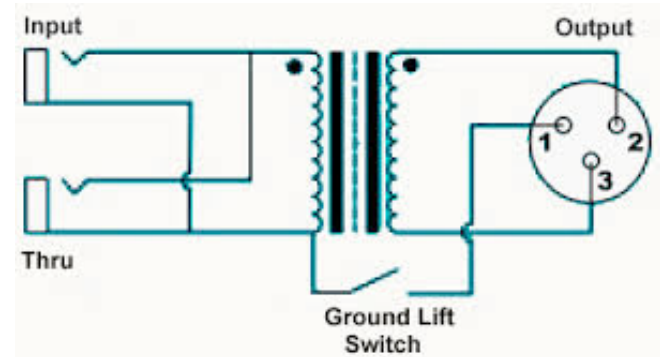
- A ground-lift or “cheater” plug *removes* the safety ground capability from the device
- Using one may allow you to plug three-prong gear into a two-prong outlet *HOWEVER...*
- You should *avoid using these*, as they place you & others at risk for injury due to improper grounding
- But *if* a ground loop/conflict *is* occurring, then use of the cheater plug is “sort of ok”, allowing one piece of gear to “win” = eliminating hum. *However*, if you ever unplug the fully-grounded gear, the rest of the system will become *ungrounded* = a safety issue



Note: the “ground” tab on a cheater plug attaches to the screw on the outlet faceplate. This screw is typically *not* properly grounded, or at least you should never assume it is.

What About Ground Lift on a DI Box?

- One way of breaking a Ground Loop is to use an “Isolation Transformer” (like we did for the DC Power Supply Lab).
- The DI box already contains such a thing. (schematic)
- What’s the switch do? It connects the sleeve of the “guitar” cable to the “floating” ground (or not).
- Is that safe? For isolated guitar: Absolutely.



What Do Power Conditioners Do?

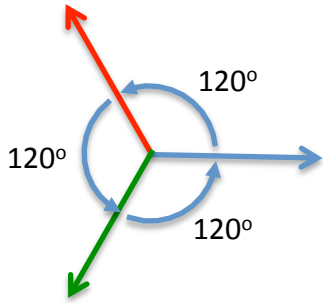


- Many users (e.g. homes in neighborhood), turning things off & on at random intervals
 - Causes noise and fluctuations to level
- Power Conditioners (e.g. Furman) serve 2 main functions:
 - Smooth the signal
 - Remove high-frequency noise / blips (via choke)
 - Regulate the Line Level
 - Keeps voltage from going too high...
 - ...which could damage sensitive equipment
 - Example: Producers home studio where power would go up to 127VAC
 - Last a long time, generally ok to buy used

Checking for Grounding Issues

- Use an outlet tester
- Pattern of lights tells you what's up
- Bring one with you to gigs
- Diagnoses common issues:
 - Bad ground
 - Hot & neutral reversed
 - Open neutral
 - GFCI testing





Three-Phase Power

- “Normal” house/building current is single-phase
- 3-Phase is often used for industrial applications, especially when motors (e.g. induction motors) are involved
- The 3 phases are separate AC signals, which are 120° out of phase with each other
- Allow for efficient driving of motor
- Also allow for 3 separate single-phase lines, or one 120V & one (nearly) 240V line
- For any other issues related to 3-Phase Power,
HIRE AN ELECTRICIAN.
Do not mess with 3-Phase Power yourself.