

## Diagnosing and Fixing Ground Loops to Prevent AC Hum/Buzz

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### What is a Ground Loop?

When you hear hum in an audio system, it's almost always caused by a loop antenna effect between two or more pieces of gear, across signal lines. A loop antenna is formed by having a loop of wire where the beginning and end of the loop are connected - the loop can be any shape. The loop antenna (e) is basically a form of radio antenna and they tend to pick up the 60Hz AC signal (50Hz in Europe) being broadcast by a building's electrical wiring. Loop Antenna can also pick up 120Hz, 180Hz, and all the other harmonics of 60Hz and, usually to a lesser degree, electrical noise being broadcast from all such things as fluorescent lights, dimmer switches, refrigerator /freezer condensers, central air, neon signs, coffee pots, etc... These loop antennae are closed circuits usually through the ground wires and hence are commonly called **ground loops**.

Examples of Ground Loops:

1. Going up the AC power cord ground from the electrical system wiring to a keyboard, going across a signal line ground from the keyboard to a mixer across the signal ground, down the mixer's power cord ground reconnecting to the electrical system wiring.
2. Going across the signal ground from a mixer to a reverb unit, going from the reverb unit across the signal ground back to the mixer and reconnecting inside the mixer.
3. Going up the AC power cord to the mixer, across the signal ground to the amplifier, down the amplifier's power cord ground and reconnecting to the electrical system wiring
4. Going up the AC power cord to a guitar amplifier, going across the input signal ground to an effects device left channel output, from the effects device right channel output to another guitar amplifier, down the second guitar amplifier's power cord ground and reconnecting to the electrical system wiring.

### Which connection has the Ground Loop? (AKA Playing Audio Detective)

Identify the ground loop causing the trouble; not all ground loops cause noise or hum. For complex systems you may need to repeat these steps starting with a different piece of equipment in various combinations to locate the problem:

1. Strip the system down to one essential piece by disconnecting all interconnects and AC cords except for the mixer.
2. Add one piece of equipment at a time; hook up AC and interconnects (making sure all grounds are connected and in good condition) then listen for hum or noise.
3. Turn on and off the power each time you switch equipment to avoid pops and shorted outputs.
4. Proceed until you find the offending piece(s) causing the problem.
5. (For 120V US Style Outlets Only: If the offending piece of gear has a three prong power plug, try using a ground lift adapter (an adapter that converts a three prong power plug to two prongs. If the noise decreases or goes away, you can use our Hum X device to safely remove that Hum.

**IMPORTANT NOTE #1:** The Hum X has a maximum current draw rating of 6 Amps. Check the gear specifications to make sure you are not exceeding this limitation.

**IMPORTANT NOTE #2:** Using a ground lift adapter is NOT SAFE for regular use. You can damage your equipment with long term use (or in the case of guitar or bass rig, you put yourself in risk of electrocution!) The ground lift adapter should only be used for TESTING PURPOSES to determine if the hum is coming in on the ground pin.

6. If using a ground lift adapter did NOT change the hum, or for OTHER WORLDWIDE VOLTAGES AND OUTLET TYPES: place the Hum Eliminator™ on all audio lines before or after the offending equipment. For example ... insert the line outs of the keyboard into the inputs of the Hum Eliminator™, then insert the line outs of the Hum Eliminator™ into the inputs of the mixer.

It is often helpful to listen through a pair of headphones. Quite often you will only hear hum coming from a particular input channel on a mixer and that is where the ground loop will be. Alternatively, if you hear hum coming out the speakers with all the mixer's channels turned down, it's likely that the problem is between the mixer and amplifier or other equipment that comes after the mixer.

Another common path for ground loops is through a chassis into the rack and then into another chassis. Test this by removing the chassis from the rack. If the Hum goes away when you remove the chassis from the rack, you may need to isolate the metal

from the rack gear from the rack itself using nylon (or other non-conductive) washers. In addition, a Hum Eliminator™ will help get rid of any hum you still have at that point.

IMPORTANT NOTE #3: Never use a Hum Eliminator™ on a powered speaker line (between a power amp and a speaker).

### **Why can't I just use a ground lift or cut off the shield at one end of the cable?**

While these methods may or may not remove your hum, they create other problems that are mostly unsafe!

#### ***Removing or disabling the AC ground:***

- Can cause electrocution
- Can cause distortion due to floating signal references
- Can cause some pieces of equipment to oscillate or become damaged
- Can cause current and noise meant for the AC ground to be dumped down the interconnect (line level) to another piece of equipment instead

#### ***Cutting the shield at one end of the interconnect cable:***

- Can hinder the ability of the cable to serve as a signal return
- Can cause distortion and/or clipping of the signal since there is no voltage translation matching (shifting a signal to match ground and power supply).
- Can alter the cable's frequency response.
- Can defeat the shielding effect.

### **Why using the Hum X or Hum Eliminator™ is the safer and better solution:**

#### **ABOUT THE HUM X**

The Hum X maintains a proper ground at all times while filtering the ground line of low voltages that cause ground loop hum and buzz. Since you don't run your audio signal through anything, there is no signal loss or tone change.

#### **ABOUT THE HUM ELIMINATOR™**

The Hum Eliminator™ is completely transparent; its audiophile quality components don't change your sound. With a flat frequency response from 20Hz to 70kHz (*way beyond the range of human hearing*) the Hum Eliminator™ is the answer when the Hum X is not the proper solution or in cases where you cannot use the Hum X (in Europe for example).

The Hum Eliminator™ breaks the ground loop, keeping all AC grounds intact. It provides isolated signal returns and performs automatic voltage translation matching.

The Hum Eliminator™ automatically converts from unbalanced to balanced without signal loss. This means long cable runs won't pick up on noise from the surroundings. Balanced outputs from the Hum Eliminator™ benefit from true common mode rejection (CMR), canceling out noise from AC power cords and other sources.

The Hum Eliminator™ will match any ground potential difference between two pieces of equipment. If the ground of your keyboard is 6 volts higher than the ground of your mixer, the Hum Eliminator™ will shift the entire signal of the keyboard down by 6 volts to compensate without affecting the keyboard at all.

The Hum Eliminator™ is available in a two channel box with 1/4" smart jacks\* (Model HE-2), a two channel box with 1/4" smart jacks and XLR jacks (Model HE-2-XLR), a single space rack unit with eight channels of 1/4" smart jacks (Model HE-8) and a single space rack unit with eight channels of XLR jacks (Model HE-8-XLR).

\* "Smart Jacks" accept any combination of 1/4" TS (Mono) or 1/4" TRS (stereo) connector.

**No buzz, no hum. No signal degradation. No noise gates. No dangerous ground lifts.**

**JUST CRYSTAL CLEAR SOUND!**