

Eliminating Ground Loop Hum

by Bruce Bartlett
with Jenny Bartlett

ELKHART, Ind. You plug two audio devices into AC power, connect them together, and there it is: hum. Chances are you have created a ground loop — a major cause of hum in audio systems.

How it starts

A ground loop is a circuit formed out of ground leads. It is the circuit loop that is formed when equipment is connected to ground through more than one path.

A ground loop occurs when two audio devices connect to each other through a cable shield and also through their power cord safety grounds.

Figure 1 shows a ground loop. Two equipment chassis are connected to two separate safety grounds by their AC cords (via the round ground pin). Also, the equipment chassis are connected together by the shield of the audio cable. The

shield and safety-ground wires form a ground loop.

A ground loop also can be created between two cable shields connected to

the same piece of equipment.

How does a ground loop create hum? In two ways. First, The ground loop acts like a big coil of wire or antenna sensitive to

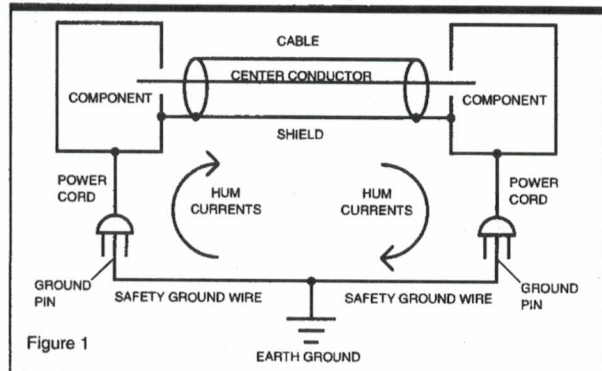


Figure 1

hum fields radiated by power wiring in the walls. The bigger the area of the loop, the more hum interference it picks up.

Second, if the voltage on each chassis is not the same (that is, if the safety grounds are different), a 60 Hz current flows between the two chassis, causing a hum signal.

Dealing with it

You can get rid of ground loops in several ways, and we will cover some of them here.

• Make the loop area small. If possible, keep your equipment close together and

use short audio cables. When running send/return cables to a signal processor, tape these cables together. When running separate L and R channel cables for a stereo hookup, tape these cables together. Better yet, use a stereo cable, which combines both channel pairs in a single cable.

• Connect each chassis separately to a single ground point. If you do this, all chassis are at the same ground voltage, so no hum current can flow between them when they are connected by cables.

Here is an example. Suppose you are doing a live broadcast of a concert. You want to connect an unbalanced recording mixer to your radio production mixer. The recording mixer is plugged into a wall outlet in one room, and your production mixer is plugged into a wall outlet in another room. When you connect them with an unbalanced cable, you hear hum. What is going on?

Differential

The outlets are probably fed from different circuit breakers, so the outlets are at different ground voltages. When you plug both mixers into these separated outlets, and connect the equipment together with an unbalanced cable, the difference in ground voltages makes a 60 Hz hum current flow between the two mixers. That is a ground loop.

One solution is to plug all your equipment into one or more outlet strips fed from the same circuit breaker. That way, the ground voltage for all the equipment is

the same, except for small chassis voltages caused by leakage capacitances.

Run thick extension cords to distant equipment. Make sure the current requirement of the system — the sum of the equipment fuse ratings — does not exceed the amperage rating for that circuit.

Another solution: insert a 1:1 isolation transformer, or a transformer-isolated direct box between the two mixers. On the direct box, flip the ground-lift switch to the lowest hum position. Unlike a cable, a transformer passes the signal without connecting the two chassis together.

If you have a small audio system with two-prong power cords and short unbalanced cables, you should have no hum problems if you followed these suggestions.

When you connect to unbalanced equipment, use two-conductor shielded cable. Tie the hot conductor to signal hot, tie the other conductor to signal ground. Tie the shield to either chassis or to both chassis, whatever gives the least hum.

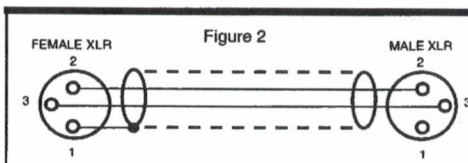
Floating a shield

Suppose you interconnect two pieces of balanced equipment, and you hear hum. Maybe it is caused by a ground loop. Disconnect the cable shield at the receiving end, so that no hum current flows between equipment.

Remember: ground the driving end, float the receiving end.

Wire the cable shields as shown in Figure 2. In each line-level balanced cable, solder the shield to female XLR pin 1. Leave the shield unsoldered (and cut short and shrink-tubed) in the male XLR.

The two conductors from pins 2 and 3 carry the audio signal. The shield still drains hum interference to ground through its single ground connection.



If the shield were connected at both ends, hum currents might flow between the two components. That is, a ground loop might be set up between the shield and the safety-ground wires, causing hum.

Ideally, the best practice is to tie the shield to chassis ground — not signal ground — at both ends of the cable.

The chassis ground should be at the point of cable entry, not inside the chassis at the PC board. Unfortunately, not all balanced equipment has chassis-grounded shields.

All mic cable shields should be tied to pin 1 on both ends, otherwise the microphone housing won't be grounded. Be sure to label your cables accordingly so you do not accidentally use an interconnect cable in place of a mic cable.

If you pick up RF interference (AM or FM radio, CB, etc.) with a floating shield, connect the unconnected end of each shield to pin 1 through a 0.01 µF capacitor.

If you locally ground a mic-connector box that is installed in a wall, this will create a ground loop. Do not ground the connector box except through its cable shield.

Loops in racks

Try to put all unbalanced equipment in a single rack to shorten the interconnecting cables.

A ground loop can occur when two

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Getting Rid of Ground Loop Hum

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chassis of unbalanced equipment contact each other through a rack. To prevent this, put unbalanced equipment in a wooden rack with wooden rack channels, and keep the chassis separated (insulated) from each other with electrical tape.

If you must use a rack with metal rails, isolate all the unbalanced rack equipment from the rack (and each other) by using electrical tape, nylon mounting bolts and nylon washers.

Ground loops can occur when you use a grounded patch panel to connect one piece of equipment to another. At the patch bay, do not locally ground the jack sleeves. Do

not float the cable shields at the patch bay between connected components.

Each audio cable should have an insulating rubber or plastic jacket to prevent ground loops. If the shield is exposed, it can contact grounded metallic surfaces at more than one point, creating a ground loop.

Inside an XLR-type cable connector is a ground lug that contacts the metallic connector shell. If the ground lug is soldered to pin 1 (the shield pin), the shell is connected to the shield through the ground lug and pin 1.

Ground loops or shocks may occur if the shell touches a metallic surface. So do not connect the ground lug to pin 1.

An exception might be in the controlled

environment of a studio. When grounded through pin 1, the shell acts as a shield to reduce pickup of hum and radio-frequency interference by the conductors inside the shell.

Some phantom-power supplies will hum if the mic cable connector shell is grounded to pin 1. Keep this in mind.

There are many more ways to stop hum, and we will cover them in future articles.

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Make Most Of Digital

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MiniDisc, for example, or APT apt-x100 on Fidelipac systems?

• Question No. 3: Is the ability to network these recorder/editor systems of primary importance? Do you prefer any specific protocol?

• Question No. 4: Should the recorder unit be separate from a companion editing system? Should the ability to capture audio on location or in the studio be a separate function from the subsequent editing of material? How should they share data?

• Question No. 5: Similarly, for hard-disk systems intended as replacements for NAB cartridge, should the record/edit station be separate from the playback interface?

Thank you in advance for your responses. Watch for the results in a future installment of Digital Domain.

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Check Your Spelling

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tracked by allied forces using GPS satellites, Satcom 1R, the Hubble Telescope and Mir Space Station.

You don't buy this story for a minute, do you? But let the station computer get a hold of it seconds before airtime and you will treat your listeners to:

Sodium Houston's movements were tracked by allied forces using gas satellites, Sitcom 1R, the Humble Telescope and Mayor Space Station.

Hmm ... Sodium Houston ... loved her last album.

When machines talk

Given the momentum of computerized station automation, we may yet see the day when we can type copy into a machine and a digitized human voice will read it back as a live spot. I for one am not looking forward to that day, but imagine the fun when the following tag is entered into the computer:

Test-drive the all-new 1996 Mazda Miata with optional ABS brakes at your nearby Mazda dealer today!

Er, did somebody say "spellcheck?"

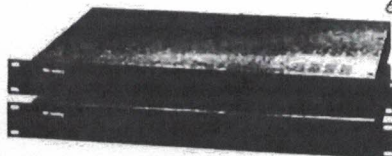
Test-drive the all-new 1996 Musty Meaty with optional obese brakes at your nearby Misty dealer today!

When you are done explaining to the screaming manager at the dealership why the tag aired like that, come on back to the station. I'll have the hard disk system play Musty for you.

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