

Audio Component Grounding and Interconnection

This is a very short summary of the material extensively covered in the [main article](#).

Audio Component Grounding

Most grounding problems are caused by something being connected to the wrong ground or ground current flowing where it is not needed. “Wrong ground” implies that there is more than one kind of ground and I differentiate grounds as follows:

- Safety ground – this is the separate (green or green/yellow) wire in the power line going back to the circuit breaker panel. It is connected to earth at the panel.
- Chassis and cable shields – These provide protection from electrostatic fields.
- Power common – This is the 0 Volt reference from the power supply.
- Signal reference – This provides a point of reference for the signal in a circuit.

These grounds need to be connected together in a very specific manner as part of the design of a component grounding structure. Grounding should be designed as carefully as any other part of the component and I encourage you to make a map of the grounding structure to show up any potential problems. Here are some rules to help you plan your grounding structure.

Rule 1: *Each of the following must be connected to the system star ground by one and only one route.*

- All signal references
- All power commons
- Shields of non-galvanically isolated single-ended inputs and outputs
- Safety ground and chassis. The safety ground and chassis should be thought of as a single entity.

The connection may be direct, or indirect through a star-of-stars or buss. This is expanded upon below.

The safety ground and chassis may be connected to the system star ground through a [Safety Loop Breaker Circuit](#).

The “one and only one” part of this rule precludes ground loops. There is no excuse for a ground loop within a single component.

Rule 2: *The shield of a balanced input or output (XLR pin 1) must be connected to the chassis at or as close as is possible to the connector.*

Rule 3: *The shield of a single-ended input or output that is not galvanically isolated must be directly connected to the system star ground.*

The shield is the signal reference in the cable

Rule 4: Any circuit associated with an input or output that is not galvanically isolated must have its signal reference directly connected to the system star ground.

Rule 5: The mains safety ground must be directly connected to the chassis. From [IEC 60950](#), “The wire is terminated with a closed loop connector which is fixed to the earthing stud or screw with a star or lock washer and a nut. Other parts of the product that need to be earthed are connected by closed loop connectors to the same stud and locked with an additional nut. It is important that the earth wire from the power supply cord is located at the bottom of the stud and locked with its own nut. The earthing stud must not be used for any purpose other than earthing. It cannot be used, for example, for the mechanical fixing of parts other than the earth conductors. Its mechanical structure must also be such that it cannot be loosened from outside the device. For example, it cannot be a post fixed with a screw from outside the product.”

Rule 6: Each signal reference must be directly connected to its power reference.

That is, no circuit may have its signal reference connected to its power common through another circuit’s signal reference or power common. This rule allows for a star-of-stars with the signal reference and power common directly connected together in a star and that star connected to the system star (either directly or through a buss).

Rule 7: Circuits may be grouped together with their signal references forming a buss.

- The order of the grouping is not arbitrary. Just as the signal is routed along, stage to stage, the associated signal reference can be routed with the signal between stages. Keep the signal and its associated signal reference electrically close together; they should be treated as a pair. This minimizes the risk of noise being injected into the signal reference.
- One end of the buss should be connected to the system star ground, either directly or by a star of star.

Audio Component Interconnection Summary

1. Provide a dedicated branch power line, or at least a benevolently loaded one, for audio components.
2. Plug all audio components into the same power strip or power outlet.
3. Provide a separate branch power line for computers, TVs or any other devices having switching power supplies.
4. Provide isolated interfaces for connections between:
 - a. The audio system and other devices, like computers or TVs.
 - b. Pin 1 Problem devices and any other audio component.
 - c. Class 1 component and a class 2 component.
Isolation may not be needed for this case.
 - d. Class 1 component and an SLB isolated component.
Isolation may not be needed for this case.

5. Loops aren't bad – it depends on what is on the loop.
6. Use shielded heavy gauge twisted pair interconnect cables.

[Understanding, Finding, & Eliminating Ground Loops in Audio & Video Systems](#) by Bill Whitlock has a lot of great information on solving interconnection problems in audio systems.