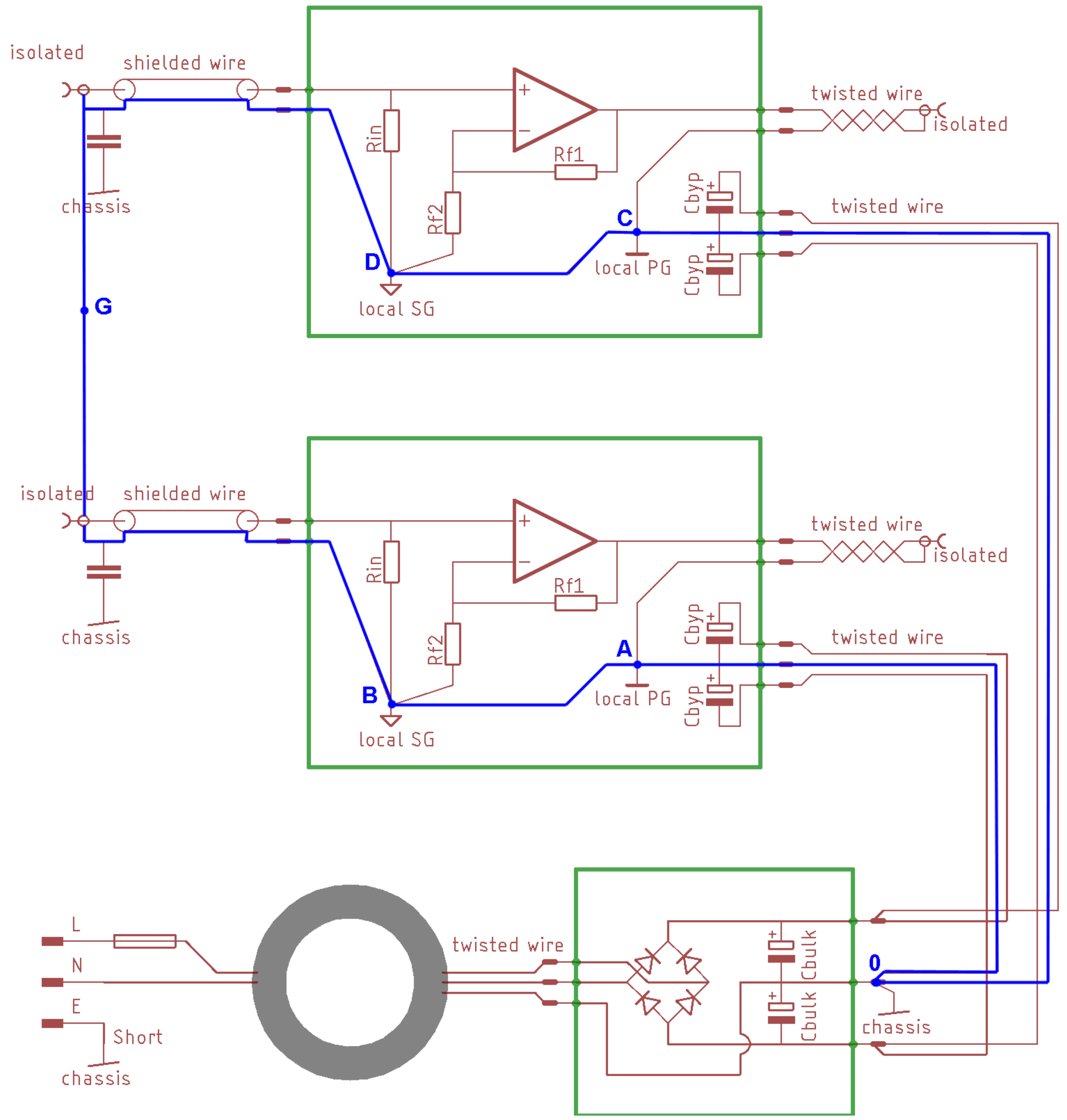
[ilimzn](#)'s Excellent Posts on Ground Loops



Here is the first diagram from the start of the thread, with the internal loop highlighted.
The loop goes through 6 points, 0-A-B-G and 0-C-D-G.
G is shown as a single point although I have brought a line between the ground ends of the interconnect cables - this will normally be very short, just a metal link between the left and right RCA connectors on the source, usually less than an inch. So, for the purpose of the argument, let's assume it's a single point.

This loop presents two problems.

Problem 1 is the voltage developed between 0-A and 0-C by the load current. The net result is a voltage between A-C that is proportional to the difference between channels. Sections A-B and C-D are usually very short (a track on the PCB), while B-G and D-G can be quite long (meters) as this is the ground of the interconnect cables. While all of these are in miliohms, it's the relative resistances that are a problem. Because A-B and C-D are very short compared to B-G-D, the voltage developed between A and C appears almost unchanged between B and D. Since B-G and D-G is about equal, the voltage between B and D is about evenly distributed between G (ground of the source) and the ground of the interconnect cable on the amp side - in other words, about half of the difference voltage developed on the section A-0-C by the load currents through this part of the wiring, is added to the input of each channel.
While the voltage drop on A-B and A-C is driving the common ground for the input and the feedback on each channel, the output only amplifies this already comparatively smaller error voltage by the difference in gain between the inverting and non-inverting input referred part of the signal, which is a difference of 1 (non-inverting is -Rg/Rf, inverting is 1+Rg/Rf), so this is not much of a problem compared to the sections G-B and G-D - this error voltage is fully amplified as it appears in series with the input voltage! This will affect the signal separation. Also, keep in mind part of the load current is carried by the PCB tracks and the interconnect grounding!

Problem 2 is the current induced by any electromagnetic field within this loop. This can be really insidious, as it is common (usually for cooling reasons) to put one channel of the amp to one side of the enclosure, and the other channel to the other side, while the PSU and transformer is in the middle. This may put the transformer right inside of the loop, where the loop acts as a single turn secondary for the stray field of the transformer.
Since the loop is a single turn, even with a very bad magnetic coupling, it can develop a lot of current through the loop, resulting in seizable voltage drops even on the miliohm resistances of the wiring. Since the sections D-C-0-A-B are inside of the enclosure and usually present the lower resistance part of the complete loop (interconnects can be quite long!), you can expect most of the voltage drop around the loop to appear on section B-G-D, which again puts half of this voltage in series with each of the source outputs to form the input voltage of the amplifiers. These will then be amplified in full by the amplifiers.
Keep in mind that part of this loop is outside of the amplifier (the interconnect cables) but the induced voltage here will be canceled by the same induced voltage in the live wire in the interconnect. The error occurs due to error current generated only in the ground wires.

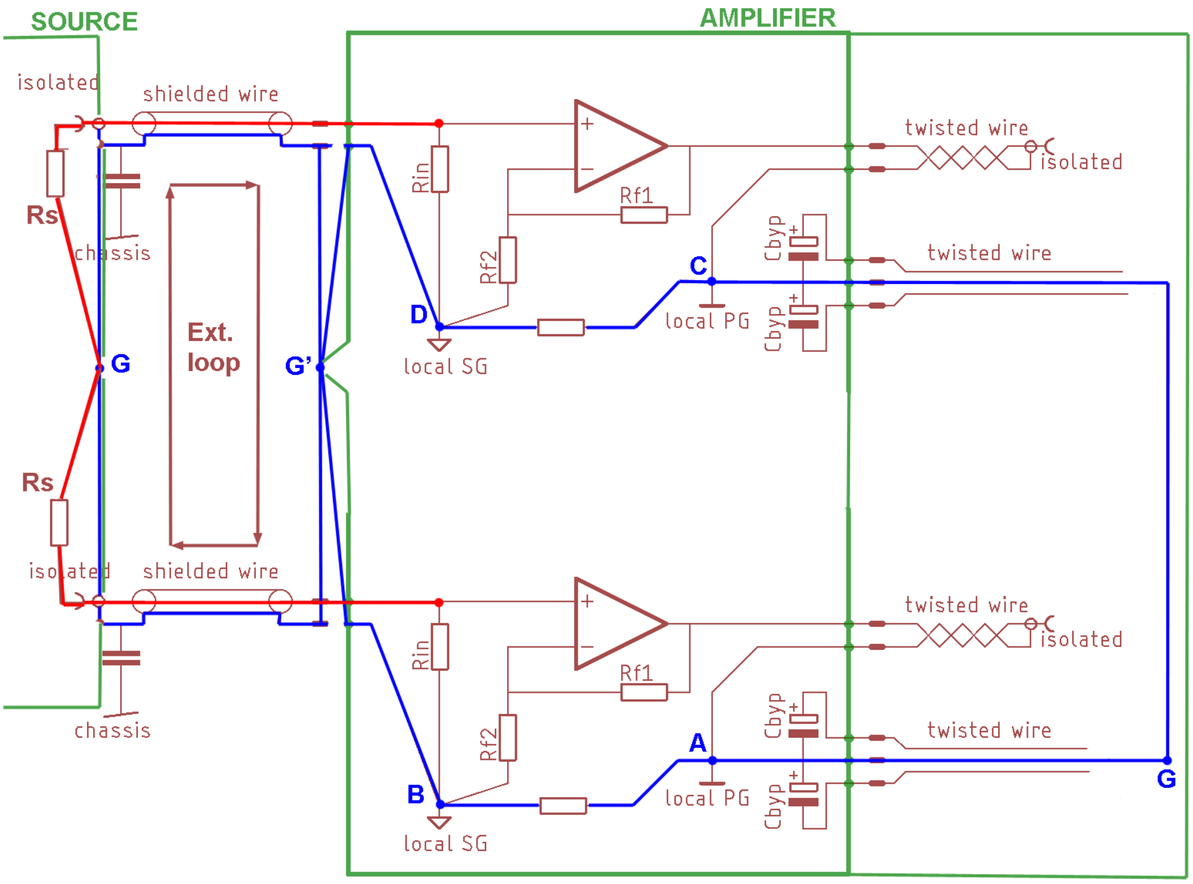
Both loops are insidious as they will not appear when the amplifier is cehcked and measured without BOTH inputs attached to a source with a common ground on the source side - the amp will be dead silent and work great with only one channel attached.

Given that when one channel is connected the loop is broken, we may use this idea to implement a deliberate break in the loop. However, we can'e completely separate the ends as we still need a ground reference.
Here's where the 10 or so ohms resistors come in, positioned one each between points A-B and C-D.

For problem 1, the value of these resistors is usually very small compared to the values of Rin, Rf1, Rf2, there will be a small difference between the ground and actual ground reference for the amplifiers, of any difference in currents between Rin and Rf2, but this is normally so small it can be disregarded. The main difference happens because of the

voltage drop on the ground wiring to the load, due to the difference in load current. However, this may be reduced by using low impedance wiring and, depending on topological layout, by alternative ground wiring.
While we still get that difference between points A and C, but now it is localized to the output. Because the 10 ohm resistors are a very large resistance compared to the wiring section B-G-D, a very large portion of the voltage difference between A-C is actually dropped on the resistors, and a very small portion on B-G-D, to the point that B-G-D can be disregarded. Typically the difference can be as high as a factor of 500-1000, easily even more if the input connectors on the amplifier itself are brought close together and the grounds connected on them, which makes the section B-G-D essentially appear at the amplifier end of the interconnects and have an extremely low resistance.
Although this will then still be amplified by the amplifiers, the total error signal on the output will be reduced by a factor of ~40dB or so compared to the original picture - usually this will be well below noise and distortion of the amplifiers, hence not so relevant any more.

For problem 2, the result is similar. Again, the critical voltage in the loop is what appears on the loop portion B-G-D. Most of the loop doing the inducing is A-0-C, and again, most of that voltage is dropped on the 10-ohm resistors, so that the remaining voltage B-G-D is very small due to the low resistance of this section.
However, there is a caveat here. One must remember that a part of the loop is outside of the amplifier, the ground parts of the interconnect cables. I have mentioned before that for best results regarding channel separation can be had if the input connectors for the two channels are located close to each other on the amplifier enclosure and the grounds on them connected together with the lowest resistance practicable. This remains true also for the induction problem in the loop BUT ONLY for the inside of the amp. More about this in the next post.



Consider the picture below.
On this picture, the internal ground loop breaking resistors have been added, and the R and L input RCA connectors on the amplifier have been connected together by the shortest practical path (preferably they will be both very close to each other).
There is a similar situation on the source side.
Because of this the connection of the L and R connector is marked as a single point, G on the source side, G' on the amplifier side, these are reference grounds on the source and amplifier side respectively.

While the problem with the internal loop has now largely been solved using the ground loop breaking resistors (between points A-B and C-D), and the input ground point moved to the input RCAs on the amplifier enclosure, to point G', we still may have one problem - the outside ground loop going around through the interconnect cables, from source ground G through the left interconnect to G' and back through the right interconnect to G.

Because the interconnect runs are usually the same length, both sections G-G' have roughly the same impedance. usually this will mean that the current induced in the loop will create the same voltage in oposite directions in the cables, so it will cancel out and G and G' will roughly be at the same potential.

HOWEVER - the same voltage is also induced in the signal wire of the interconnect ('hot' wire) because they circumscribe the same loop path!

While the wires see a low impedance on the source end (usually tens or low hundreds of ohms) the other end is connected to G' via Rin, which is a much larger value, usually 10s of kohms. As a result, each input of the amplifier will see half of the induced outer loop voltage added to the source output, and will amplify that!
It is obvious that in this case there is a clear violation of signal transfer rules through interconnects - current through the forward and return wire must always be equal in magnitude and opposite in phase. This cannot be the case because for the loop voltage the ground wire loop is low impedance, while the signal wire loop is almost open at the amp end.
In this case the only solution is to minimize the loop area and with that any possibility of current induction into it - which is why it is always recommended to RUN L and R INTERCONNECT CABLES BUNDLED TOGETHER!!!! and why old style interconnects had these wires bonded together by the outer isolation.