Eliminating Ground Loops

by: Joe Ging, E.E.

Commercial mixer/amplifiers (regardless of brand) all suffer from some of the same audio challenges. Most of the issues result because a mixer/amplifier (by definition) is designed for a "Swiss Army Knife" approach that offers dozens of different types of audio connections in the hopes of providing an easy "Plug & Play" solution for the user. I'm writing this paper because the Lowell MA Series mixer/amplifiers experience the same audio issues as mixer/amplifiers made by other manufacturers in the industry.

So you wire up a new commercial audio system using a Lowell MA Series mixer/amplifier, and you can hear a low level 60Hz hum/buzz through your speakers. Your first suspicion may be that one of the pieces of audio gear is faulty out of the box, or one of your cables is bad. While that may be the case, it is more likely that you have a problem with the dreaded audio "Ground Loop". Dealing with "Ground Loops" can be one of the most frustrating issues that can face an audio technician. Ground Loops are caused when 2 different pieces of audio equipment have multiple paths to earth ground. Small voltage potentials can exist between the equipment, even when all units are grounded. The current that flows in the ground or in the shields of audio cables, can induce a 60Hz hum or buzz in the audio signal chain that can be heard through the speakers. The classic example in the A/V Industry is when 2 pieces of audio gear are mounted in the same metal equipment cabinet. Both have grounded power plugs that are plugged into the same power source, both are grounded because they are mounted in the same metal equipment cabinet, and both are grounded to each other through audio cables (as shown below).



So many different paths to ground can create so many ground loops in this "Classic Example", it's difficult to show them all on one drawing, but the schematic below gives you an idea of what we're dealing with.



The best way to deal with a situation like this is to work on one ground loop at a time.

1) Rack Mounting:

Most professional audio electronic equipment has a grounded AC plug and the ground on that plug is tied to the metal chassis. When that piece of equipment is mounted in a metal equipment cabinet, a ground loop is created as shown below:



An amateur audio technician's method to deal with that ground loop is often to lift the ground on the power cord of at least one piece of equipment, by using a grounding adaptor shown to the right. Note that this practice not only violates the NEC (National Electrical Code), but it can create a dangerous shock hazard. Those grounding adaptors (that you can buy at any hardware store), were developed for and are approved for only one purpose. When an old-style 2 blade ungrounded wall receptacle is mounted in a grounded outlet box, a truly grounded connection can be created by screwing down the ground tab of the adaptor to the outlet plate screw. These adaptors were designed to provide a ground, not to lift or avoid a ground. Any other use of these adaptors is not recommended and can create a very dangerous shock hazard.



Typical Grounding Adaptor

The best way to avoid ground loops caused by rack mounting (while leaving the power plug safely grounded), is to use isolation washers that will allow you to mount the mixer/ amplifier in the rack, with no electrical connection between the audio equipment's chassis and the metal rack rails. Note that isolation washers are included with all Lowell MA Series mixer/amplifiers as shown in the install sheet below:



With the power cable to rack rails ground loops eliminated, the only ground loop path that must be dealt with is the "Audio Signal Path" which can create a ground loop through the grounded power cables as shown below. Unfortunately, audio signal path ground loops can be more difficult to deal with because they depend on the audio circuitry in the devices that are connected. Still there are some basic steps that should be tried.



1) Butting Shields

This is the most cost effective solution because no additional equipment is required. Since the chassis of both pieces of equipment are already grounded, there is typically no need to tie the shield of the audio cable down at both ends. It is industry standard practice to butt (disconnect and isolate) the shield at the output of the signal feeding equipment, and tie down and drain the shield at the input to the next stage, as shown below:



2) Transformer Isolation

Butting a shield does not always eliminate the hum/buzz problem, especially in unbalanced lines with RCA connectors. That seems to have a lot to do with circuitry in the devices that are being connected. If that method does not resolve the issue, the next step is to insert a device with transformer isolation. Both ends in this case remain shielded (with no shields butted). The transformer provides complete ground isolation and eliminates any ground loop in the audio path as shown below:



Note that all of our examples have dealt with ground loops that are caused when equipment is mounted in a metal equipment cabinet. There are times when pieces of equipment that are connected together create a hum/buzz, even if they have rubber feet and are placed on a shelf so there is no ground loop created. Sometimes that has to do with the internal circuitry of the devices. The transformer isolation shown above for ground loops, can sometimes clear up problems when 2 pieces of equipment just don't like to be connected because of impedance mismatches or voltage potential differences.

Lowell Manufacturing does not offer a transformer isolation device, but many are available on-line. Be sure the device you choose includes a transformer (many don't), and make sure the device you choose has adequate frequency response for your application. The 2 devices shown below have been tested in the Lowell Manufacturing Lab and perform well, but there are many other models on the market that will also work.

