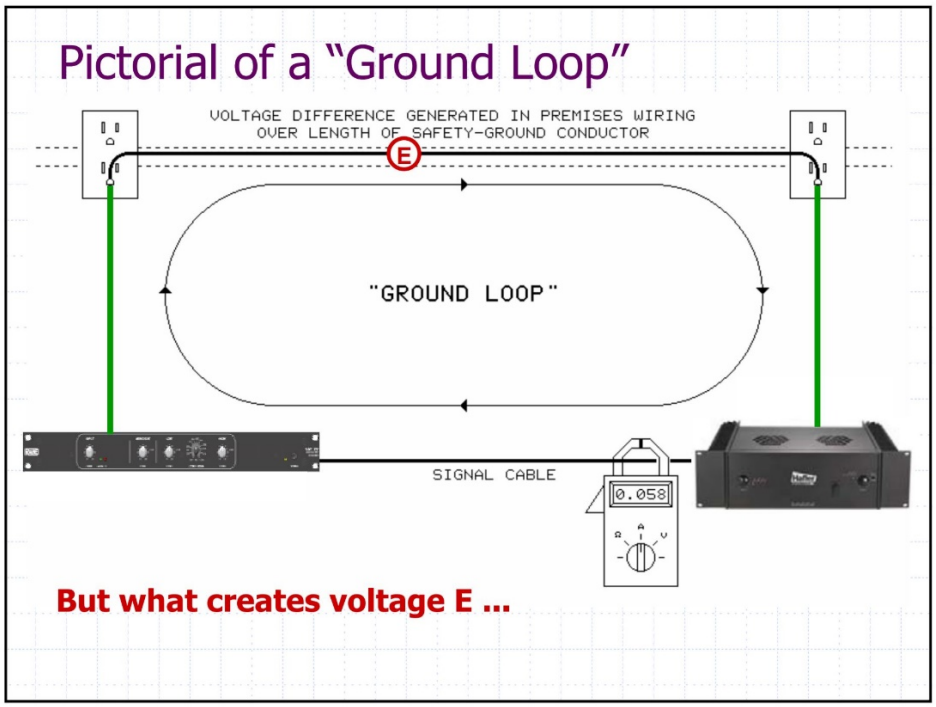
Grounding, Audio Wiring, and Zero Loop Area Design

By John H. Brandt

> First of all, when it comes to sticking your hand into the electrical service panel, you should really know what you are doing. Never perform DIY on your electrical panel without proper permits and qualified supervision – meaning a licensed electrician who knows the local electrical code. That said I will move on to explain the optimum procedure for grounding and wiring your audio system.

Grounding

The primary reason for grounding is safety. As a primer for this paper, please read Bill Whitlock's "UNDERSTANDING, FINDING, & ELIMINATING GROUND LOOPS IN AUDIO & VIDEO SYSTEMS".



"Broadly, the purpose of grounding is to electrically interconnect conductive objects, such as equipment, in order to minimize voltage differences between them. An

excellent broad definition is that a ground is simply a return path for current. We must remember that current always returns to its source through either an intentional or accidental path - electrons don't care and they don't read schematics!"
- Bill Whitlock

Zero Loop Area

The term "zero loop area" was coined by Neil A. Muncy, who I had the pleasure to work with in 1998. As a reference, I have his AES paper, "Noise Susceptibility in Analog and Digital Signal Processing Systems".

It is the voltage difference generated between the safety ground and the audio ground (shield) that causes the noise issues. But if there is no area in the loop, the voltage difference drops to near zero and the noise follows.

The **area** of the ground loop is critical.

"Another name for a ground conductor is antenna. Anyone who has ever been frustrated when attempting to solve RFI problems by using a wire to "ground" things together is at least painfully, if not consciously, aware of this reality." – Neal A. Muncy

Application:

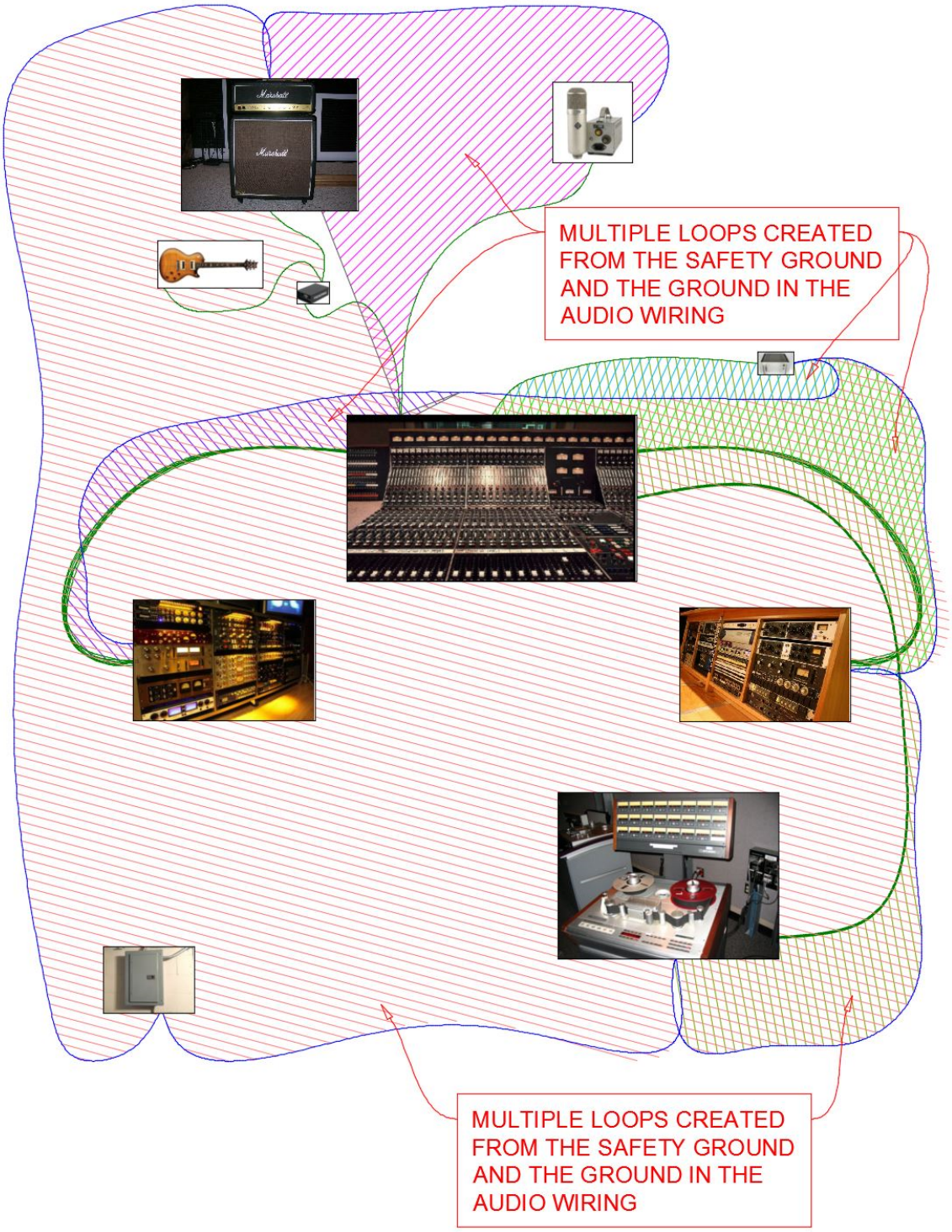
Many remedies have been recommended for studio wiring problems. The number one solution was OEO, or 'One End Only'. Where the shield and drain wire for any balanced connection is connected only at the source side. This effectively cuts the loop. However, it is often discovered that the degree of noise reduction resulting from adherence to the OEO rule is not completely adequate. While LF noise may be reduced to some extent, interference from nearby RF sources may become worse.

In the following drawing you can see shaded areas that form ground loops. More loop area equals increased noise and interference.

Ground loops only occur when all ground wires are connected at both ends of equipment as happens with a tube microphone that is powered in the tracking room with its own power supply that is plugged into the electrical system.

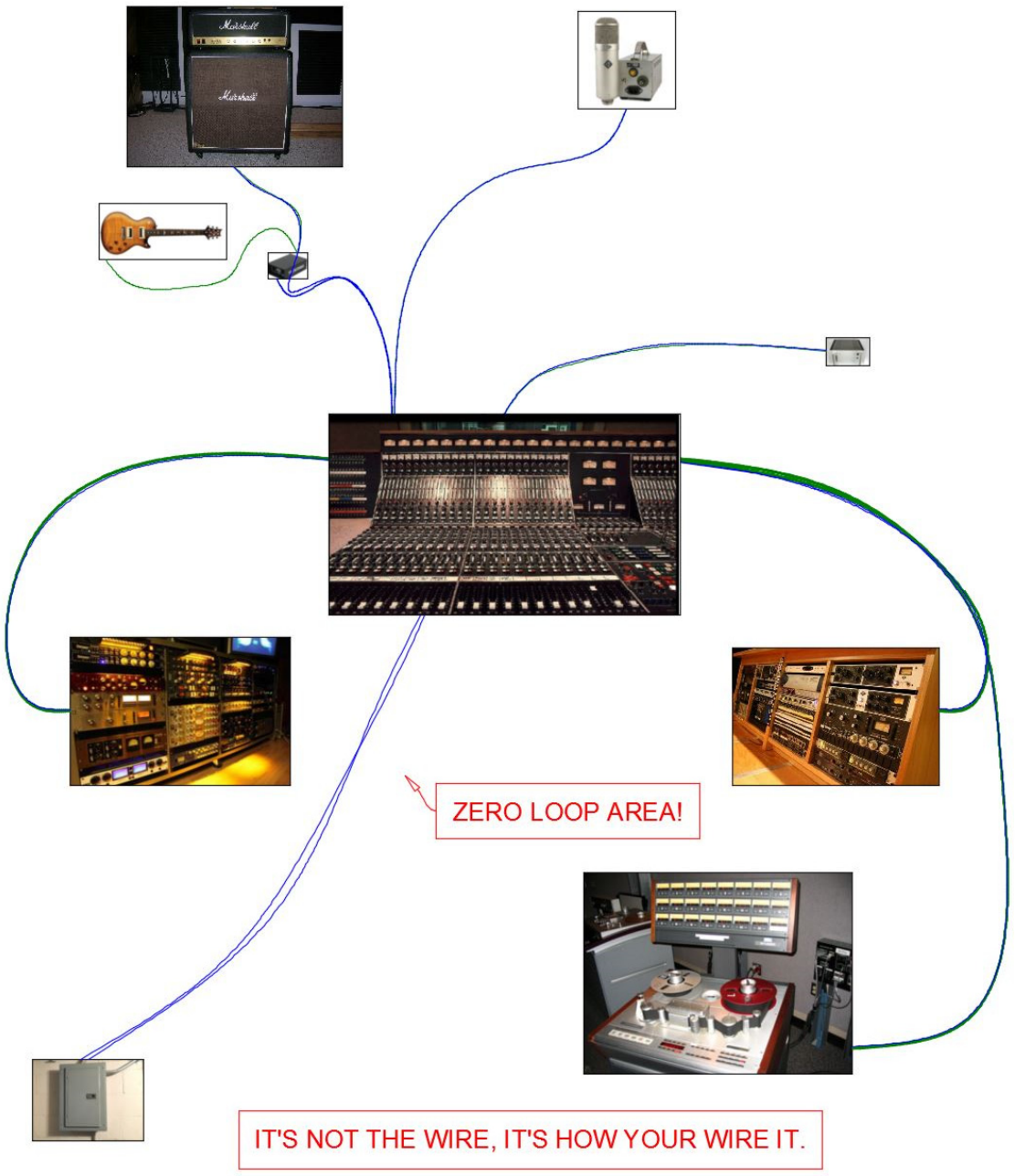
The microphone cable, which has a ground, is connected to the console and is grounded to the electrical system from its power source. The power source for the microphone is also grounded to the electrical system. The loop area is defined as the area encompassing all the associated wiring for the system or any component of the system.

Below, you can see how ‘normal’ wiring affects the loop area.

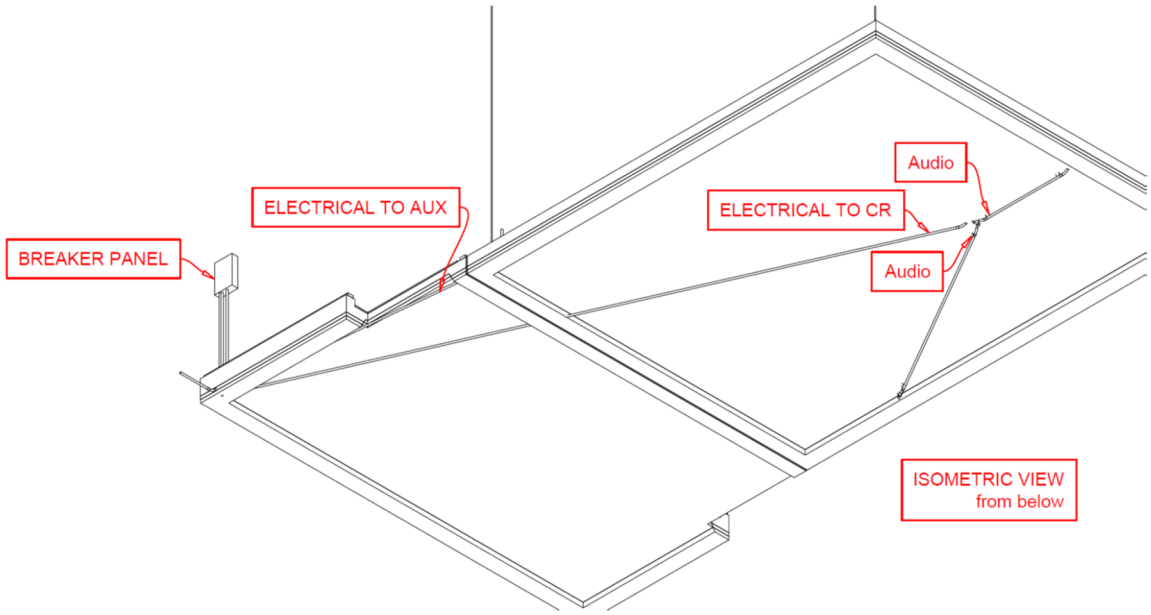


Loop area will introduce the ambient electromagnetic field into the audio system; 50 or 60 Hz depending on your local power frequency plus all the unwanted harmonics and electromagnetic hash that may be present due to dimmers and other hash producing equipment, etc. The solution is to collapse the loop.

This drawing shows implementation of the ‘Zero Loop Area’ wiring.



All audio lines follow the path of the electrical lines to prevent loop ‘area’.



Here is an actual build incorporating this wiring technique:

The conduits on the floor will be exposed in the front of the control room and feed the desk/console. This ties them into the system while maintaining a zero-loop area wiring system.

It is recommended that these conduits be tied together with zip-ties to keep them as close as physically possible.

Clean studio power is run in a dedicated conduit. When long runs are required from control room to tracking room and booths, the runs are direct as possible and do not loop around the room. This is accomplished by running the electrical for audio conduit in the ceiling or floor. Run a straight line with short branches as necessary. The audio cabling must run in larger conduit(s) right next to the electrical conduit. This procedure eliminates the loop area in the connected ground wires.

When plugging into the patch panels and/or using an extension cords, always keep the lines short and bundled tightly together as much as possible. The exception to this rule would include ungrounded wall wart transformers and unshielded line transformers which must be kept at least 3ft. or 1 meter away from any unbalanced audio lines. The stray magnetic flux from these unshielded units will induce a smooth low frequency hum into unbalanced audio lines and must be kept at a safe distance away from them.

The following page shows a close-up of how to install the conduits.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The following pages show the installation of the conduits below a concrete slab.

Conclusion:

It's simple: Run all audio lines and power lines together, in separate conduits, to eliminate the loop area. Pay close attention to the spacing. Space them as close as physically possible to avoid creation of loop area. When this technique is applied properly, a myriad of problems is avoided. OEO wiring is no longer required and, in fact, not recommended.

- John H. Brandt