Ground Loops

If you use a commercial interface between your rig and your computer you probably do not have a ground loop in your system. However, if you have tried to "go cheap" and just hook cables between your rig and computer you may well have a ground loop. If you are thinking about building your own interface or just directly hooking up cables between your computer and rig or just wondering why your need that expensive interface listen carefully for the next few minutes.

A ground loop causes a buzz or hum in audio equipment and this includes the rig in your shack. This may be confused with and sound identical to power supply noise or ripple. Usually it is a 60 hertz tone. Ground loops are sometimes difficult to identify and even more difficult to troubleshoot.

What may sound like just background electronic noise may in fact be a 60 hertz tone from a ground loop. However, some ground loops have such a loud and distinct sound there is no doubt even to the untrained ear that something is amiss.

If you operate amateur radio equipment and especially digital modes with a computer providing the digital data and decoding you need to understand ground loops and how to eliminate them.

A ground loop occurs when the ground potential between two pieces of equipment is not identical. How does this occur? Your computer and rig each has a separate ground connection to the AC electrical ground in your shack. Fine so far. Now if you want to hook your computer to your rig for running digital modes or for any other reason there is a separate ground provided between the two by the cables you use to connect them together. And, you have thus formed a ground loop. Electrical current flowing from your rig or computer to ground now has two paths to the AC electrical ground in your shack. Thus, a loop is formed by the attaching cables. Hence the name ground loop.

Why does this cause a hum in the rig's audio? Well, glad you asked!!

Your computer and your radio have separate power supplies. In your computer it is normally built into the case whereas in your rig it is

usually external. Each will have a separate ground back to your AC ground system. The cable connection mentioned a moment ago causes a ground loop as we said. Each power supply is using a different amount of power causing a different current to flow in their separate AC grounds. (This is leakage current in the ground system…..not normal return current flow on the AC neutral line.) When they are connected together by an audio cable there is current flow between the two power supplies by way of the ground side of the connecting cable. This current flow causes one the power supply with the least leakage current to be above AC ground potential. By doing this, AC current is superimposed on everything in that piece of equipment. Thus that piece of equipment will have a 60 hertz tone, read that buzz or hum, superimposed on all audio it produces. As the two are connected directly together by cables both in turn will have the 60 hertz superimposed on their audio.

In actual use we normally only directly use or hear the audio from one of the pieces of equipment. Thus we have the impression it is coming from that piece of equipment. However, both pieces working together produces the annoying hum.

Eliminating the 60 hertz tone.

From our previous discussion it seems obvious that if we somehow break up the ground between the two pieces of equipment involved the ground loop and the resulting buzz or hum will disappear. But, how do we do that and still transfer the audio or data between the two without having a direct ground between the two. Long ago we all learned that for any circuit to work there has to be a return path for the electrons. How do we provide the return path and not induce a ground loop?

In amateur radio there are two basic ways in practice. In other disciplines such as in broadcasting and recording studios there are other ways. However, today we will limit our discussion to amateur radio.

Think back to basic electronics and you will remember there are two ways to move an ac signal such as audio or data between two point and at the same time to block the flow of DC current. Right, transformers and capacitors. Capacitors are not used for a variety of reasons. First, because there would need to be two, one for the audio and one for the

ground side where as only one transformer is needed. Capacitors for audio and data frequencies are larger than transformers for the same frequencies and pass less frequency range than transformers.

Thus, properly selected transformers will break up the ground loop and allow audio and data signals to pass from your computer to your rig.

Now isn't that easy!! A few words of caution however. Select the right transformer. Assure it will pass the frequencies involved. A good quality audio transformer will work. In practice transformers are polarity sensitive between their windings and should be hooked up so that the low side on each side of the transformer connects to the ground side of their respective pieces of equipment. Follow manufacturers instructions.

Well, we have eliminated the ground loop of the audio and data. However, we still have another ground loop to content with. How does your computer tell your rig when it is sending audio or data? Press To Talk (PTT) is right. This is a simple DC level change on a pin in a serial port on your computer. But, it needs that all important ground return to make it work.

A transformer will not pass the DC level change of the PTT. Now how do we get that DC level change to our rig without creating the offending ground loop in the process?

How about an optical coupler? The DC level change is coupled by a small light emitting diode inside an integrated circuit to a light sensitive transistor inside the same integrated circuit. There is no DC path between the two and yet the level change is sent to the rig to key it for transmitting. Pretty nifty isn't it. Isn't electronics amazing.

We've now keyed our rig to transmit audio or data coupled thru a transformer without forming a hum producing ground loop.