Hum & Buzz

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You just spent good money on new audio gear to record a telephone interview. You strap on headphones and hear this annoying hum and buzz that you did not hear over you telephone handset. Not quite what you were expecting from this new investment.

We'll start with an explanation of the problem. This is going to get a bit technical, so if it gets boring just skip to the potential solution.

The Source

There are several possible sources to the problem, but we'll focus on the two most likely candidates. One unavoidable source is the coupling of power line noise into the phone line. Power line noise consists of 60 Hz AC hum plus its distorted harmonics. Telephone lines are run in close proximity to power lines because they are similar utilities. While the good, clean, 60 Hz AC fundamental frequency presents the strongest front; it is below the low frequency limit of the telephone line bandwidth. In other words, it is difficult to hear the 60 Hz hum over a telephone handset or speakerphone. While this is true for the clean 60 Hz signal, there is a lot of distortion on power lines at higher, more audible frequencies. AC motors, appliances, and light dimmers cause intermittent loads on the power line causing noise to be sent back down the line at harmonics of the 60 Hz signal. The higher the harmonic (180, 240, 300 Hz...), the more audible it will be.

Telephone lines are designed to be somewhat immune to noise that is coupled into the line. First, the copper wires are twisted for added immunity to noise introduced by a parallel noise source. Second, the two wires form a balanced differential connection. In other words, your voice is transmitted on both wires at the same time; only the wires are electrically 180 degrees out of phase with each other. Any noise that is coupled onto the phone line is likely to be present at the same level and in common phase on both wires. This is called common-mode noise. At the end of the line, one of the signal paths is inverted 180 degrees and then added to the other. The original signals (your voice or the caller's voice) become twice as strong, while any common-mode noise is cancelled out. While this works great on paper, the methods for canceling the noise are not perfect. This process also assumes that the noise is exactly the same on both wires, and that the wires are electrically identical. In other words, some of this noise will get through on both ends of the call.

The Second Source

There is another part to the power line noise equation; although this one is more manageable. The remaining AC hum may remain barely audible if you are simply connecting to another audio device that is not connected to anything else, as long as that device is battery powered. On the other hand, if your audio device is AC powered but not electrically grounded, you may suffer from a terribly exaggerated hum that was not present until you connected the device to your telephone interface. "Electrically grounded" means there is either a) three pronged power cord, plugged into a properly wired three-pronged outlet, or b) the device is connected to another piece of equipment that is grounded.

Picture your phone line as two wires just floating above the ground. They are referenced to each other, not to earth ground. Any power line hum that was not cancelled remains on both the signal and common lead of the audio output. Now you introduce another product powered by an AC power supply that is not grounded. Just as the phone line contains some residual AC hum on both leads of the audio jack, the power supply of this new product may also contain a similar hum. There may also be a large difference in electrical potential between these two products, which also fluctuates at 60Hz. All of these opposing waves can add up to an overwhelming part of the audio signal creating a nasty hum.

The Solution

The solution to the second, or larger part of the problem is quite simple: ground your system. With a lack of electrical ground on either the phone line interface or your audio accessory, the combined products are free to oscillate relative to each other, making for a nasty hum. By connecting an electrical ground to any audio jack outer connector or shield, you "anchor" the system, stopping the fluctuating audio hum.

The residual hum and buzz that is already in the audio signal is probably there to stay. You could try running a low-cut or high-pass filter in software after you capture the audio to your system. Many software programs have this feature. They can easily remove the lower, 60 Hz hum, but may have a tough time removing any distorted harmonics that are mixed in with the caller's voice.

