

Transmission Lines

Unbalanced lines (Guitar cables, RCA cables, anything with only two conductors)

In an unbalanced line there are two conductors. One conductor is ground. The other is the signal we are interested in. That signal may be the output of a CD player, or the output from the pickup of a guitar. These are both totally different signals and signal levels. Regardless of what the signal is, there is one signal and one ground, and that's it. Any noise picked up along the way will be there at the other end of the cable and may be annoying. It may be noise from a parallel running power cable, mysterious line noise, or maybe even a local radio station. Sometimes you can move the line away from power cables or other things and help minimize it, but this is noise picked up by "inductance" – through the air, from cable to cable, or maybe your cable is just acting like a big antennae. You're stuck with it because you're using an unbalanced line.

Balanced lines (Mic cables, TRS cables, MOST things with three conductors)

In a balanced line there are three conductors. One conductor is the original signal – sometimes called the "hot" or "positive". The second is a copy of the original signal only it has been flipped out of phase. It is a 180° (out of) phase copy of the original – sometimes called the "cold" or "negative". These two signals are completely identical except that when the hot signal goes up, the cold signal goes down, and vice-versa. The third conductor is ground.

The advantage is extreme resistance to noise. The theory is that any noise picked up along the way will be picked up equally in both the hot and cold conductors. It also makes sense that the noise picked up along the way will be in phase with itself on both lines. Remember that we intentionally made the audio signals out of phase. The ground is still just ground.

The real magic happens at the receiving end of the line. The cold signal is flipped back in phase with the hot signal. Now we have two in-phase copies that when added together equal DOUBLE the signal we put in at the start! Read that again. Keep in mind that the noise was picked up equally in both lines and it too has now been flipped out of phase, thus "phase canceling" any and all noise that was picked up along the way. This is just brilliant. We get twice the signal we put in at one end, and any noise picked up along the way (in the line) is killed.

It requires an electronic circuit or a balanced transformer to create this out of phase copy at the beginning of the line. It takes another one to change it back at the other end. Inside a microphone they use a small transformer to create the two copies passively. In the mixing board they use a circuit to flip the cold back in-phase with the hot. Transformers and electronic circuits add cost to things and this is why we don't use balanced lines for everything – cost of manufacturing. Generally only mic level and line level devices use this balancing process. If we tried to use it with speakers, the cost of the transformers would be astronomical because of the huge power they would have to deal with from power amps. It doesn't matter in that case though because any noise picked up in a speaker cable is likely to be massively overwhelmed by the HUGE signal coming from the power amp.