Longitudinal Interference to Twisted Pairs Carrying Voice Signals

Interference to a pair of wires carrying voice signals can be separated into two components, called metallic and longitudinal. Metallic interference is an interfering signal applied from one wire of the pair to the other wire, Figure 1 below.

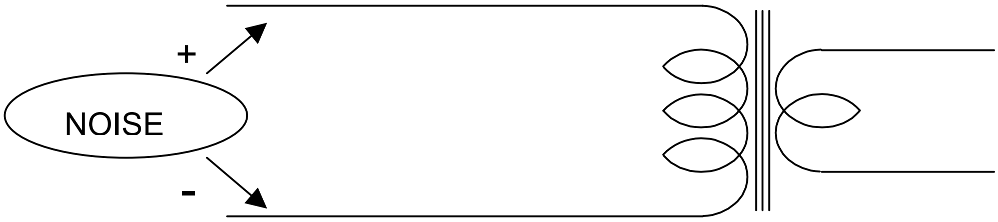

Figure 1 – Metallic Interference

The metallic interference will result in noise that can be heard. Metallic interference can be reduced by careful twisting of the wire pair, Figure 2.

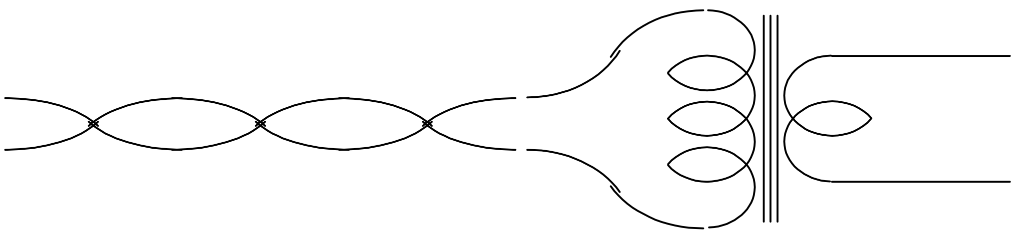

Figure 2 – Twisting Wires to Reduce Metallic Interference

In this way, the interference on one wire of the pair is balanced by equal interference on the other wire. This converts metallic interference into longitudinal interference.

Longitudinal interference is an interfering signal applied equally to both wires with respect to ground, Figure 3.

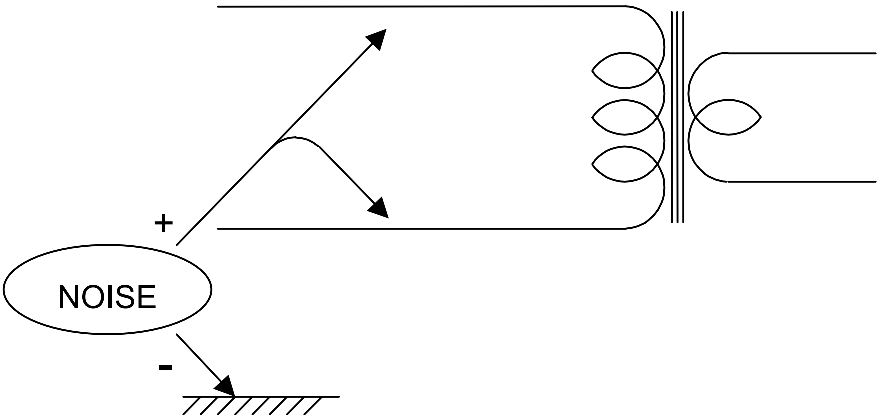

Figure 3 – Longitudinal Interference

In the diagrams above, the legacy circuit using a transformer is shown. With a transformer, longitudinal interference will be blocked.

Excessive longitudinal interference, however, will still result in some noise in the voice signal. This is because the two wires of the twisted pair may not be perfectly balanced. In Figure 4 below, the unequal impedance to ground between the two wires to ground will result in some longitudinal interference converted into metallic interference.

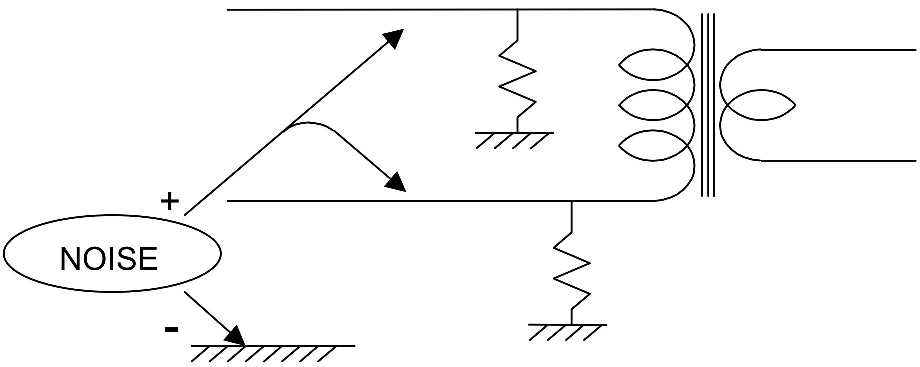

Figure 4 – Longitudinal Interference Converted to Metallic

The above discussion assumes the use of transformers in the voice signal path, which are legacy circuits. Modern voice signal circuits use solid state devices instead of transformers, Figure 5. This is to save cost and space.

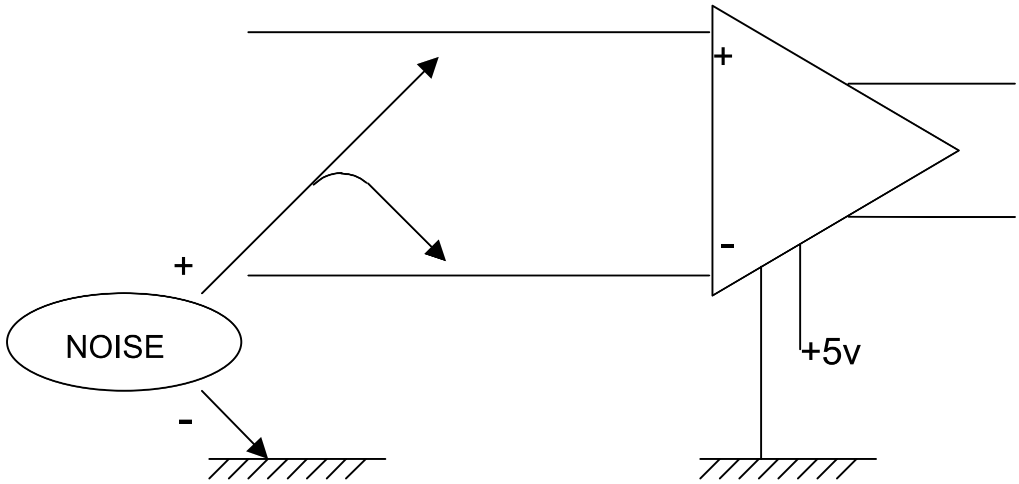

Figure 5 – Solid State Voice Pair Termination

In theory, the longitudinal interference reaching the amplifier should be cancelled out by the differential action. The specification of the IC chip states that the residual metallic noise, resulting from unbalance, should be 65 dB below the longitudinal noise. However, there is another more serious limitation. Since the IC chip is powered by 5 volts DC, any longitudinal signal exceeding 5 volts would cause the chip to saturate and cease to function.

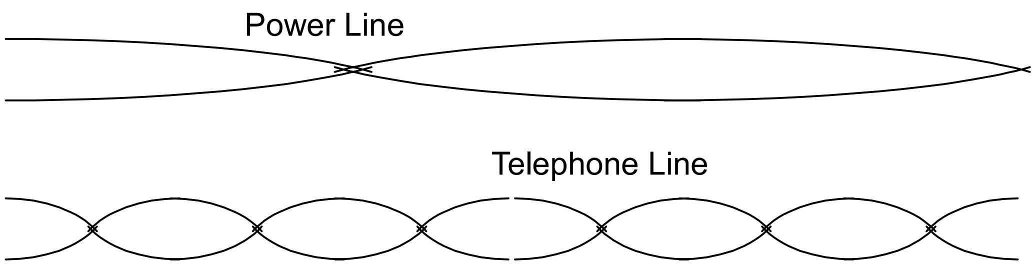

Figure 6 – Power Line to Telephone Line Interference

Most causes of longitudinal interference are caused by nearby power lines. For outside installations, the telephone company and the power company practice "induction coordination" to prevent interference from power lines to telephone lines, Figure 6. This usually involves the twisting of the power lines as well as the telephone lines, using different twist pitch.

Inside of a building, power lines are often placed close to telephone lines. In addition, the power lines are often not twisted. Therefore, large longitudinal voltages can occur on the telephone lines. Measured longitudinal voltages reaching 65 volts can and do occur. In such cases, the telephone equipment using solid-state technology as the front end would not operate properly.

While the best way to prevent longitudinal interference is to control the source, that is, (a) separate the telephone lines from the power lines, and (b) provide twist in the power lines, this is often not the case in buildings. Once the longitudinal interference is discovered, it is usually too late to change the building wiring. Another method, though not the best, is to install a bypass filter for the longitudinal interference, Figure 7.

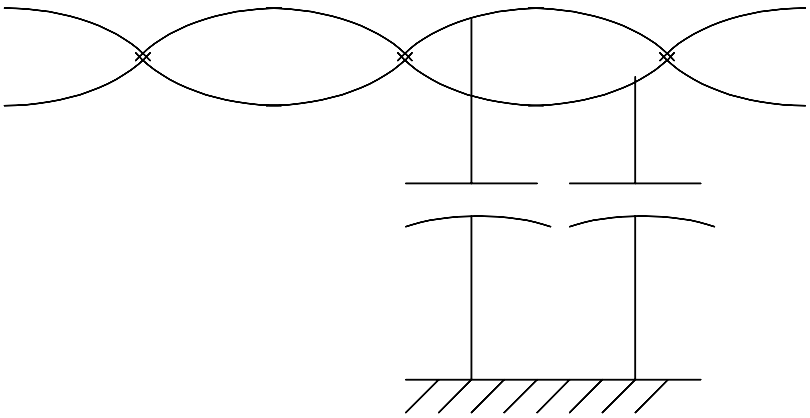

Figure 7 – Longitudinal Interference Filter

Although such filters will cause some degradation of the voice signal, at least the longitudinal interference will be reduced enough to allow the circuit to function. This filter functions by acting as a voltage divider between the power line coupling and the capacitive coupling to ground of the filter, Figure 8.

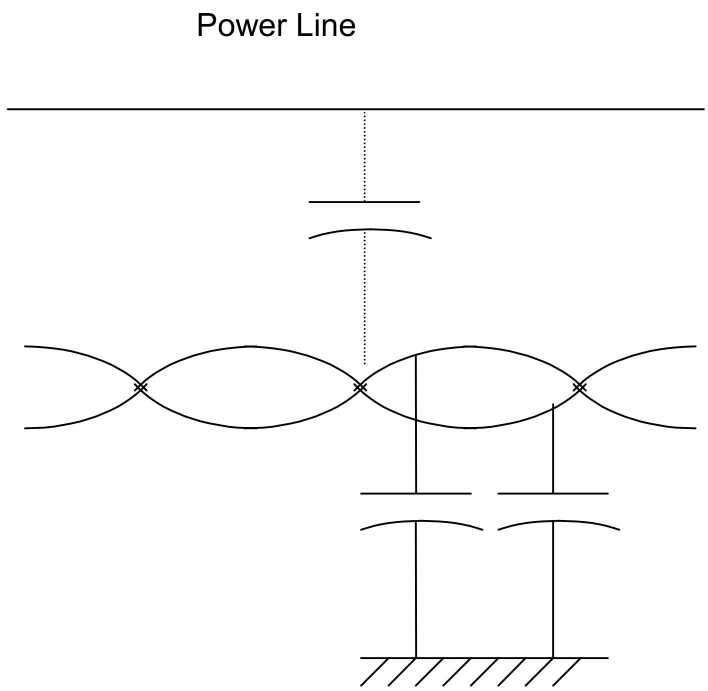

Figure 8 – Filter Acting as Voltage Divider