The Science of Cable Design

Part IV

The Audio Cable as Low-Pass Filter and its Role in the Pursuit of Neutrality

In the last three installments, we examined the aspects of cable design, which have the greatest effect on performance: conductor design and arrangement, and dielectric design and materials. We also showed how the differences between cables could be measured and correlated with the listening experience.

In this installment we'll discuss the cable as a second-order low-pass filter and examine the subject of neutrality in an audio cable.

With its series inductance and parallel capacitance, an audio cable is a simple second-order low-pass filter. By reducing the inductance and capacitance, we can increase the bandwidth of the cable and extend the cable's frequency response.

Within its frequency response an audio cables' capacitance remains fairly constant with frequency, but the inductance in the cable varies with frequency This is due to the inductance being dependent on the diameter (or shape) of the conductors and the configuration of the conductors within the cable. These changes in inductance cause audible differences, which will be different with different component output/input impedances. When the electromagnetic field (inductance), which varies with frequency, interacts with the electrostatic field (capacitance), this causes different electrical resonances and filtering effects within the cable interface. Depending on the diameter and configuration of the conductors within the cable, the amount of inductance will vary considerably and the sound will be audibly affected.

In Part II, we examined how to reduce the series inductance by having smaller conductors, and having them in a more open arrangement. To reduce the parallel capacitance it is simply necessary to space the positive and negative conductor runs further apart. Increasing the cable's bandwidth in this way improves the cable's linearity with frequency and ensures less system interaction because of the reduced electrical characteristics of the cable.

The ideal audio cable then, has low series inductance (smaller conductors or rectangular ones with less inductive reactance) and low parallel capacitance. In this way it has very high bandwidth and is then less system dependent.

The reduced system interaction of the cable created by increased bandwidth will yield an important quality we call neutrality. Most would agree that the ultimate system is one, which brings us as close to the experience of the original musical event - whether that was in a studio or a live concert setting. We want to hear the music as it was recorded: nothing left out, nothing added. Neutrality then, not alteration or coloration is an important quality in audio cable performance.

Cables are the only component within an audio system that can be designed to be completely neutral. Every other component, by its very nature, alters the signal in some way. The theoretical ideal of an audio cable is one with zero series inductance and zero parallel capacitance. In this way the cable has unlimited bandwidth and is also not system dependent. TARA Labs cables, designed against this theoretical ideal, are designed to have the lowest LCR specs and widest bandwidth on the market.

If neutrality in your audio system is important to you, begin to narrow down your cable choices by starting with those that have the lowest LCR specs. (Any reputable manufacturer should be able to supply these figures and to explain the method by which they were obtained.) Then use educated listening techniques to determine which of the cables sounds best in your system.

Cable manufacturers, by the way, do not universally endorse this philosophy. There are other cables on the market, which are designed to act as "tone controls" for the system. They use networks, filters or additional elements that are meant to somehow improve the audio signal by altering it. In fact, these do nothing more than impose upon the system someone else's idea about how the music should sound. The result is contrived and artificial, rather than transparent and neutral. Above all, it will most likely produce colorations that destroy the natural, musical reproduction you've tried so hard to create.

Achieving complete neutrality in an audio system may be an impossible dream. After all, we are reproducing a musical event, not experiencing the "real thing." But the pursuit of this ideal is a worthy one, primarily because it puts the emphasis where it belongs: on the music.

Parts I, II and III of this series appear in Stereophile Vol. 19, Numbers 1, 3 & 5. Reprints of the series can be obtained from TARA Labs.