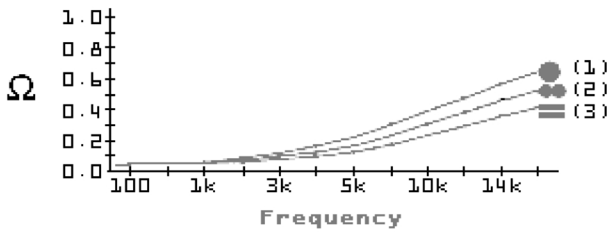
The Science of Cable Design

Part II

How Conductor Size and Shape Affect Performance; What to Look for

Constant Current Impedance Testing

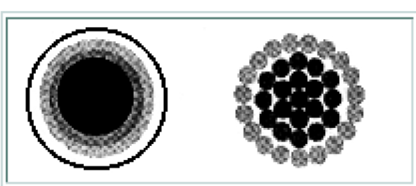


(1) = 1 x $2mm^2$ round   (2) = 2 x $1mm^2$ round   (3) = 2 x $1mm^2$ rectangular

In Part 1, we measured the frequency linearity of various cable designs using TARA Labs' Constant Current Impedance Testing (CCZT)™.

Why do different conductor types of the same mass yield such different results? In a few words: electromagnetic flux linkage.

Referring to the graph of the CCZT results, we see that the single 2 mm2 (14 gauge) conductor shows the least linearity with frequency. This is because in a larger single conductor there is more electromagnetic flux, which increases in density towards the center of the conductor. This crowding, or density of the electromagnetic lines of force at the center of the conductor effectively chokes off higher frequencies and forces them to travel towards the outside of the conductor.



Any compact or uniform shape increases the tendency of the whole conductor to have greater density in the coupling or linkage of electro-magnetic flux. In this diagram, a *stranded conductor shows the same tendency to roll off high frequencies as a single solid conductor of the same mass.*

An important note: this is true whether the conductor is a single solid-core or a stranded conductor of the same conductive mass or DC resistance. A large diameter conductor, whether solid-core or stranded, will have the same impedance vs. frequency curve for a given diameter and mass. In other words, the closely bundled small conductors in a multi-strand conductor approximate a single large solid-core conductor, so nothing is gained by stranding many smaller conductors.[1]

In the second trace, we have split the single conductor into two smaller ones. Combined, they have the same mass, but the frequency linearity is improved because of their smaller individual diameters and lower electromagnetic flux linkage. Although the conductors are subject to flux linkage because of proximity, they have the greater frequency linearity that goes with a smaller diameter. This is the principle behind many of TARA Labs' Prism Series solid-core cable designs.

In the third trace, the Rectangular Solis Core® conductors still have the same mass but their frequency linearity is improved further. This is because the rectangular conductor has less coupling of electromagnetic flux at the center of the conductor. Due to its shape, there is effectively no "center" to speak of.

What to look for, then, when choosing cables? A design with thinner conductors in a more open configuration will yield cleaner, clearer and more frequency-linear sound. One with a single, large conductor or a bundle of smaller conductors will yield sound that is smoother and rolled off.

All designs have the same conductive mass, but frequency linearity (i.e. a cleaner, clearer sound) will improve from left to right due to conductor size, shape & arrangement.

These guidelines hold true regardless of variations on these design themes and account for most of an audio cable's sound. Other elements, such as dielectric and conductor material and treatments, are the icing on the cake of cable design, having a lesser effect on cable performance than good, solid design principles. In the next article, we'll begin to examine those issues to shed some light on their relevance to audio cable performance.

[1]In fact, there is another serious compromise to sound quality with stranded conductors. Oxidation between the strands (inevitable because of the presence of tiny air spaces within the cable) produce a diode-like effect which inhibits electrical flow. This effect shows up as noise, hash, and graininess, a condition which only worsens with the age of the cable.