

AIReference silverware

AIReference by YELLOW use silver wire in most advanced products!

That is, for both speaker cables, and for interconnects. Some silver electric properties are superior to the ones measured in copper. Mostly so the electric current resistance. Direct current resistance is lower, which is relevant to cable design considerations. But, like elsewhere in engineering, the real-life silver wire behavior is not as simple as comparing resistances. Transmitting alternating electric current signals brings to table a host of issues. Direct current resistance of silver being just one among many.



Interconnects transmitting much lower electric power than speaker cables, tend to suffer less from inferior wire alloys, still..

Why? Why not?

Replacing copper with silver in audio cable design and development, can and does take performance up. But in spite of performance gains, when using silver wire, all-silver cables are not common. There are good reasons why.

First and foremost, there is price. Silver is many times more expensive than copper, gram to gram. Then there is metallurgy (casting technology and all). While copper wire has been the mainstream of electrical engineering “for ever”, silver is seen more-or-less in jewelry shops only.

The division has taken alloy technologies development in diverging directions. Copper alloy forging has been in search of better electric properties “for ages”. Silver alloys were improving other aspects, obviously.



Consequently, access to good silver wire in cable design and development is scarce. While good copper wire sources are many, good silver ones are few and far apart.

Actually..

What “good” is measurable? Resistance comes to mind first. Comparable measurement is “specific resistance”. For measured values and calculations, most times ρ (Greek Rho) symbol is used. The value of ρ for copper wire is $1,68 \cdot 10^{-8}$ Ohm meters.

Copper wire used in electric engineering comes in many “colors and flavors” of course. Best audio cable designs use optimized cast high purity copper. Currently the best copper wire in AIReference by YELLOW cables uses “8N” purity copper. That means eight nines, or 99.999999% pure copper.

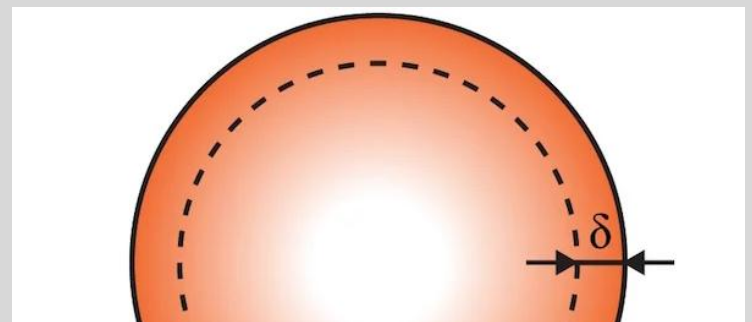
Copper purity and cast influences ρ to a degree. Wire designers tend to simplify calculations by ignoring this variation. When silver is used instead of copper, ρ is in another “ball-park” entirely, as low as $1,59 \cdot 10^{-8}$ Ohm meters.



This ρ is also used in silver wire calculations for best purity silver wire, of course. At this time, AIReference by YELLOW silver cables are built with “7N” silver cast, or 99,999999% pure silver.

What calculations?

Wire thickness and length among others, obviously. The audio cable performance aspects follow from decisions made at wire design time. Let us consider “skin effect” handling for instance.



Loss of conducting cross section, caused by high-frequency current “escaping” the wire center towards surface, troubles high-frequency electric systems designers. And not only them.

Skin effect in wires concerns top-most octave reproduction in sound systems as well. Skin depth, δ (Greek again, Delta) represents the distance from wire surface, where current density drops to 37% of its surface value. That is: to one third (!) of surface density.

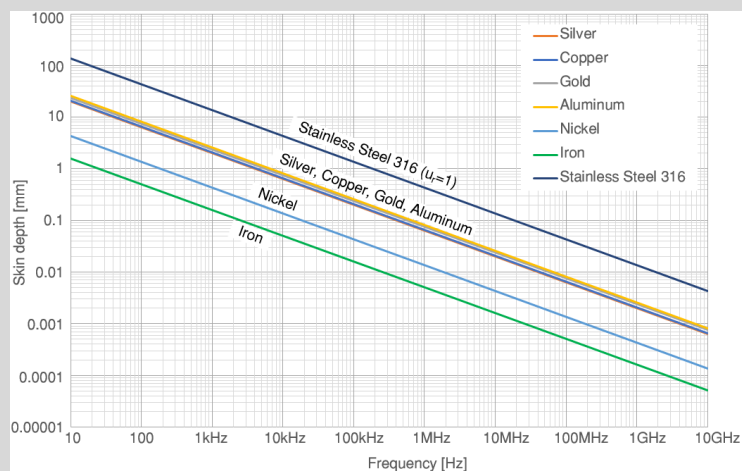
Skin depth calculation uses several input values, determined by the wire-alloy used and current frequency:

Frequency.. The higher the frequency of the alternating current signal, the shallower the penetration depth into the conductor

gets. Let us consider 20kHz sound, one has to have for phase shift reasons, although one cannot hear it.

Conductivity. The inverse of resistance. A more conductive material like silver will have a shallower skin depth at a given frequency, compared to less conductive materials. Ups, that hurts.

Relative magnetic permeability. The magnetic permeability μ (the Greek stuff becomes boring: μ) of the material affects skin depth. Coppers measure very close to one (vacuum) at 0.9999912, silvers a bit less at 0.99998.



Skin depth calculator at 20kHz gives δ of 0.461mm for copper, and 0.448mm for silver. A 3% drop in silvers. Still, when one doubles δ for wire diameter (instead of radius), one gets 0.922mm and 0.896mm respectively.

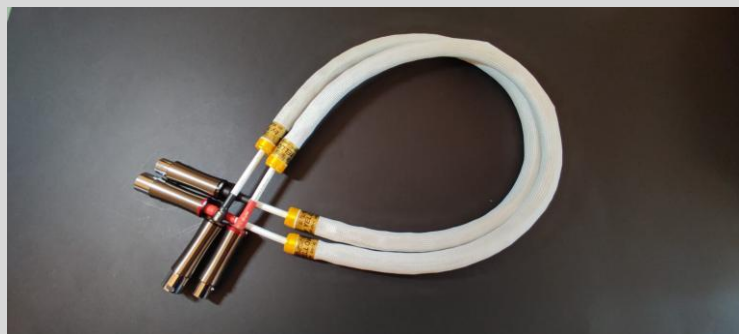
That is why AIReference by YELLOW like to keep the diameter in wires we use at half-ish the 2δ for 20k frequency, just to be sure. We would hate to have audible phase shifts in top-most octave (and below).

Connector issues

When cable build uses silver wire instead of copper, cable termination must follow suit. Used alloy needs to be high purity silver.

Cost and mechanical design specifics of silver are completely “out-of-the-box” compared to copper. Silver connector sources are rare, much fewer than copper ones. Still, there are several options.

Single ended RCA type all-silver plugs are more frequently offered, and less costly. Recent design concept developments towards low-mass, single-point contact design, help keeping prices reasonable. There is less silver used, and construction design is simpler.



All-silver XLR connectors for balanced cables, on the other hand, are hard to find. More silver is used; construction design is more demanding. The cost is understandably higher.

There is another issue with both RCA and XLR all-silver plugs. AIReference by YELLOW speaker cables production have abandoned soldering terminals a long time ago. Cold/dry hydraulic press crimping has been the preferred attachment solution since. Heating wire, therefore disrupting crystal structure is avoided at all costs.

Crimping option is not available for interconnect terminals at this time. AIReference by YELLOW design are looking into this. We hope to have a suitable build solution available soon.

Where to use silverware?

AIReference by YELLOW silver interconnects are not shielded. That lowers cable capacitance considerably, a desirable in high-end audio. Alas, nothing comes free, some induced electro-magnetic noise has to be dealt with.

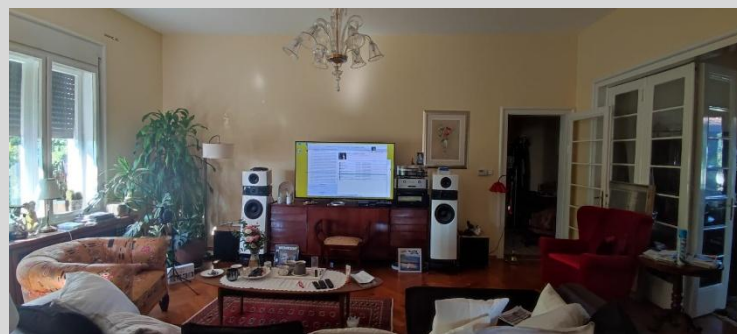
Induced electromagnetic noise is not a thing in balanced cables, Cable wiring and geometry take care of EM noise via balanced operation itself. If both source and sink are true balanced transmitter and receiver, one can forget EM.

On the other hand, single ended interconnect cables do suffer from induced EM noise somewhat more. One has to keep cable runs away from EM noise sources.

AIReference by YELLOW production will build shielded interconnects, but do not recommend it. Shielding a copper-based interconnect is not costly, but degrades performance. Shielding a silver-based interconnect degrades performance as well, but also increases cost.

Locating within system

Use silver-based interconnects anywhere within the system, where interconnects are needed. Be it source (DAC) to preamplifier, or preamplifier to power amplifier.



Note though, that the more power interconnect transmits, the more performance gains one gets replacing copper with silver. When pressed to choose one, one should target preamplifier to power amplifier interconnect.



AIReference by YELLOW interconnect design team, Zagreb, summer of 2025