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Wireworld

Making Experiential Observations Count

Wireworld Cable Technology, founded by David Salz, is a respected manufacturer of high-performance audio and video cables. I first learned of Wireworld's Cable Polygraph concept when it was introduced at Rocky Mountain Audio Fest 2015. I found the Cable Polygraph interactive listening experience to be intriguing enough to deserve my attention. So, the big question is: Do cables affect the sound we hear?

By
Oliver A. Masciarotte
(United States)

Cables, wires, interconnects, or whatever label you give them, they're generally perceived as pretty basic components, moving relatively sluggish music signals from point A to point B. There are those in the audio community who have the opinion that all wires are basically the same. The thinking is along the lines of "audio is a low frequency, low bandwidth signal." In which case, all silver or copper wires of sufficient diameter should perform the same, with inductance (H) and capacitance (F) per unit length being the only metrics affecting sound carriage. Differences in materials and geometry are irrelevant unless they adversely impact H and F. When it comes to the special case of speaker cables, a coat hanger with connectors is as good as it gets.

Photo 1: Industrial designer David Salz, the founder of Wireworld Cable Technology, attends the National Association of Music Merchants (NAMM) Show 2016. Wireworld promoted a Cable Polygraph test specific for headphone cables and Salz is holding a sample of its new Helicon 16 Speaker Cables.

Okay, I'm half joking but I'm sure you know several audio geek buddies who belong to the "fancy cable is a rip-off" camp. I was once a skeptical prove-me-wrong consumer as I had never bothered to critically listen to wire myself. Sure, I had heard opinions from fellow engineers I respect that wire matters, as does everything else in the signal chain. I also recall using, as a neophyte, a 100' length of copper Romex to carry a line level guitar from one room to another, thinking large-gauge copper conductors would be beneficial. The result was quite the opposite. I heard a dull, severely low passed sound, not what I expected with a midrange-rich source.

But, what really changed my mind was the research I conducted for a review I wrote a few years ago. Several USB cables came in for review and, I expected them to "sound" no different than the quotidian cables supplied with commodity peripherals. To my dismay, my basic physics assumptions were turned on their head. Myself and several other pro audio colleagues not only picked audio enthusiasts' choices but also consistently noticed the same sonic signatures of each cable. Before you ask, we did not perform double-blind listening tests. As audio engineers, we sat down

and listened over a long period, coolly and critically, as we would when evaluating any piece of gear.

There are many engineering-driven audio enthusiast cable vendors, each with their own approach to solving the problems of how to make a cable inaudible. One sensible way, assuming you have trained listeners, is to start by comparing a cable under test to two connectors soldered together back to back. Basically, substitute the shortest possible connection with the device under test (DUT), and listen to any differences. David Salz thought that, "if you backed your components up and docked them directly together, you would hear them at their best."

David Salz

Salz is president of Wireworld, Inc., which is located in Davie, FL. From an early age, Salz considered himself an audiophile, early on developing his car stereo installation hobby into a business (see **Photo 1**). Leaving his job at a car stereo distribution company when he was 21, he became a retailer and began testing cables. In 1980, he performed prototype Cable Polygraph tests, which set the future direction he would take. In 1981, he founded Straight Wire, gaining experience in manufacturing and marketing high-end audio cables, while honing his skills as a designer. In 1991, he sold his interest and founded Wireworld the following year.

I own several Wireworld cables, and was familiar with the company when, late last year, I attended one of Salz's Cable Polygraph demos at Rocky Mountain Audio Fest. With National Sales Manager Larry Smith assisting, Salz audibly demonstrated the differences between a minimalist bypass and various cables. On a nicely resolving playback system in a hostile acoustical environment—Bel Canto, Bryston, and Torus components driving Cinema Reference Surround 2 speakers—I could still hear the losses imposed by several examples, while the distinctions between a shunt and Wireworld cables were inaudible in that environment.

A least possible direct connection for testing is not that difficult to fabricate, minimal length OFC copper tubes insulated with Teflon being one example Wireworld has used, but it does pose some logistical challenges when you try to arrange the test subjects so their I/O ports physically align. Over time, Salz decided to build the next best thing, a minimal signal path manual switch box to test his hypotheses. He patented that design and has gone on to promote minimal interconnect vs. DUT live comparisons to be as important as objective electrical testing when refining new cable designs.

Photo 2: Wireworld's patented Cable Comparator

Wireworld's Cable Comparator

During development and production, Wireworld performs the expected objective measurements on its products, including Time Delay Reflectometry (TDR), a highly sensitive method of detecting and locating defects within a cable. That said, the company also refines its designs with subjective listening tests, using the cable comparator widget. According to the patent, the device provides a switchable, "short (path), direct connect, low loss electrical" comparison between a DUT and a minimalist signal path. The robust comparator, shown in **Photo 2**, "...includes high quality RCA female ports or jacks directly coupled to the terminals of the switch assembly. The interconnect cable comparator reduces and eliminates, if possible, electrical losses and electrical signal distortion between electrical channels established through the signal input ports, the switch assembly, the four pair of interconnect cable ports, and the signal output ports."

When asked how the comparator enables the design team to effectively achieve better sounding products, Salz made it clear that objective electrical tests do not tell the entire story. He suggested that the technique of comparing cables to direct connections, with or without a switching device, is the only way to hear exactly what cables do to the sound.

"Since my goal is to create cables that let you hear all of the music, I have always relied on these objective tests to discover what's actually being lost and changed by cables. Over the last 30-plus years, I've been using that knowledge and methodology to formulate better and better solutions to preserving the beauty and expression of music," states Salz. Even with its minimalist path and silver contacts that wipe as they switch, the cable comparator itself is now bested by Wireworld's top-of-the-line interconnect product.

A fundamental question is what known factors affect cable sound. In addition to capacitance and

About the Author

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Table 1: Skin effects are shown for copper at three frequencies.

Frequency	Resistivity	Magnetic Permeability	Skin Depth	Equivalent Diameter	Approximate Gauge
20,000 Hz	1.68E-08 Ω·m	0.99999	0.000461009 m	0.92 mm	19 AWG
30,000 Hz	1.68E-08 Ω·m	0.99999	0.000376413 m	0.75 mm	21 AWG
40,000 Hz	1.68E-08 Ω·m	0.99999	0.000325983 m	0.65 mm	22 AWG

inductance, there's channel skew, DC resistance, skin effect, and secondarily, triboelectric effects. Channel skew or, as Wireworld calls it, signal skew is arrival time disparity between the two stereo channels which, in cables, is primarily caused by variations in the length of conductors. Wireworld's proprietary Delineated Neutralizing Array (DNA) Helix geometry ensures that the conductors are exactly the same length. Also, unlike many audiophile cable products, Wireworld's offerings are manufactured on automated lines in the US, Taiwan, and China to ensure consistency. Full production runs of the cables are tested with TDR. Individual cables are also tested at the point of assembly.

Frequency-Dependent Current Density

DC resistance is well understood, easily controlled with careful supplier vetting, and is particularly important in speaker cables where DC resistance degrades damping factor. Skin effect or frequency–dependent current density is another topic brought up when discussing cables. Unless really thick conductors are used, a thoughtfully designed cable should not exhibit any skin effects at audio frequencies. **Table 1** shows the result of calculating the formula, = 503 × (SQRT(B/(C*A))) or skin depth, at several frequencies for copper. A conservative wire gauge equivalent is also shown.

Assuming any design should work at two times the required bandwidth, I included 40 kHz, which requires a 22-gauge copper conductor or smaller. Of course, most cable geometries include multiple conductors, so the point is practically moot. Indeed, Salz mentioned that skin effect is often a minor portion of the audible electromagnetic effects heard in a cable. "A cable with closely spaced 20 AWG conductors will have far less electromagnetic loss and phase shift than one with widely spaced 30 AWG conductors."

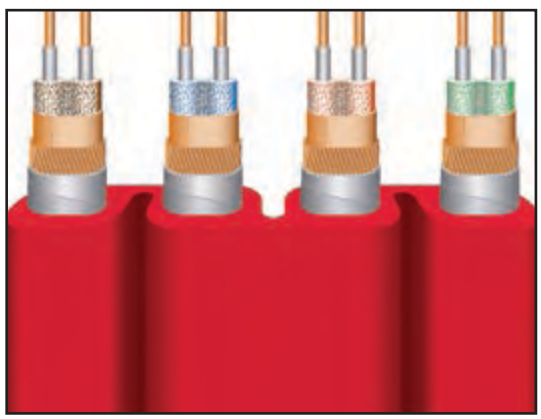

Figure 1: Wireworld previewed its Starlight Cat 8 Ethernet Cable at CES 2016.

Design Aspects

When asked about why reactance adversely effects sound quality, which conductors and dielectrics are "better" and why, and less obvious design aspects such as understanding how each parameter affects what we hear, Salz opines that "... there is no substitute for objective listening tests." An interesting phenomenon that Salz noticed during his research and development is that inductance, not capacitance, is the primary metric that drives a cable's "sound."

"The first thing I learned from my Cable Polygraph...tests is that tonal coloration and dynamics are controlled by the electromagnetic field, which actually moves the signal through the cable. As with magnets, this field gets stronger as the two polarities move closer and weaker as they move apart (following an inverse square law). For the best preservation of music, a cable's positive and negative conductors must be parallel and very close together to efficiently channel the field energy. In analog cables, the width of the gap between the polarities must also be tuned for sonic neutrality. Technically minded readers will be pleased to learn that this tuning also optimizes square wave fidelity. The goal of my DNA Helix conductor geometry is to create the most efficient channel for electromagnetic signal energy, because that provides the most complete and enjoyable musical experience," Salz states.

Optimized square wave fidelity pays off not only in the audio regime, but in data networking, where extremely high-frequency square waves are bi-directionally transmitted over a copper cable and must arrive at the receiver fairly intact. Wireworld has developed a Category 8 Ethernet cable which, according to *Wikipedia*, requires carriage of "... operating frequency up to 1.6 GHz," significantly faster signaling that the common Cat 5 cable typically used and many orders of magnitude higher than audio. **Figure 1** shows a cutaway of Wireworld's Starlight Cat 8 Ethernet Cable, which the company previewed at CES 2016.

The patented DNA Helix design used by Wireworld

consists of a stacked array of flat conductors, which are twisted together and tightly compressed within a composite shield. This geometry controls inductance (see **Figure 2**).

In addition to purportedly channeling the electromagnetic field energy more efficiently than other designs, this configuration also provides superior immunity to EMI/RFI interference. The conductors in Wireworld interconnects are insulated with Composilex 2, a second generation proprietary material that minimizes triboelectric noise and noise modulation distortion, resulting in quieter backgrounds and cleaner transients than cables that utilize conventional insulation materials.

Wireworld's Helicon 16 series of compact speaker cables, designed for internal wiring and DIY applications, use a slightly different, flat parallel geometry. These highly flexible cables consist of two flat conductors that are twisted and bonded together. This bonded helical structure stabilizes the conductors, eliminating the need for an external jacket. Helicon of 16s' two flat insulated conductors contain 16 parallel copper strands that are arranged as eight pairs (see **Figure 3**).

There's that triboelectric word again...Once the electromagnetic performance of a cable is optimized, the effects of various insulation and conductor materials are much easier to hear. Triboelectric effects are controversial in the audio community though, if you've ever manhandled a microphone cable while it's plugged into a high gain preamp, you know cable microphonics is real: an observable and audible issue.

Salz attributes the differences heard with various insulation and jacketing not to dielectric absorption, as "...measurements show those differences to be miniscule." Through testing, he found that the main reason for variations heard with myriad insulating materials is that they add different spectra of triboelectric noise to the music. "This noise is mixed with the music," Salz said, "so we hear it as unnatural tone, glare and congestion that masks quieter sounds. This discovery prompted me to develop ultra–quiet composite insulation materials, which preserve the natural tone and subtle details that make live music so enjoyable."

Once a suitable, low noise insulation and geometry for efficient electromagnetic transmission are identified, the sound should be quite good, even with basic oxygen–free copper conductors because, as Salz says, "...the major cable problems have been solved." Upgrading a cable from copper to silver will improve resolution, but that's not always helpful because "...it makes the colorations caused by insulation materials and electromagnetic effects much easier to hear." Salz believes the higher cost of purer and more conductive metals in cables is only justified when holistically designing for neutrality.

Figure 2: A DNA Helix cross section shows Wireworld's patented conductor geometry.

The Results

So, what can an avid listener gain from this discussion? Remember that cables sound different in different systems but not, according to Salz, because they are doing different things to the sound.

"In testing, we've found that cables always do the same things to the sound, but those specific things can sound very different depending on the sound of everything else in the system. That's why the sonic descriptions based on comparing one cable to another tend to be so inconsistent...(Cable Polygraph) testing creates sonic descriptions that are remarkably consistent and accurate, no matter what components are used for testing. Therefore, these (direct comparison) tests provide the most reliable predictions of how a cable will sound in various systems." For more information about Wireworld, visit www.wireworldcable.com.

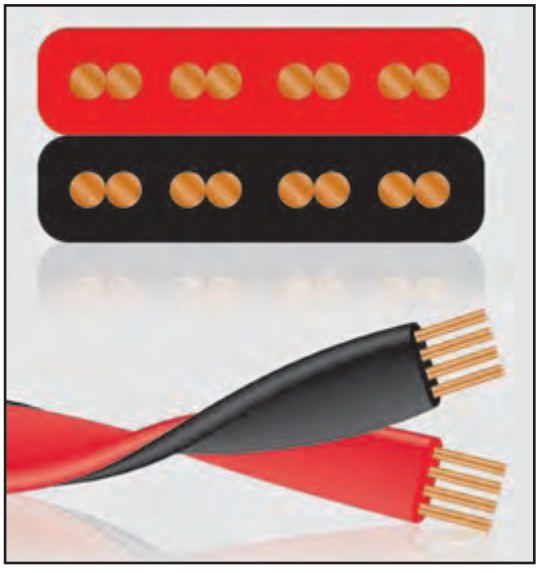

Figure 3: Wireworld's Helicon 16 series of compact speaker cables is designed for internal wiring and DIY applications. These highly flexible cables consist of two flat conductors that are twisted and bonded together. This bonded helical structure stabilizes the conductors, eliminating the need for an external jacket. Helicon 16's two flat insulated conductors contain 16 parallel copper strands that are arranged as eight pairs.