Why AC Power Cables Make a Difference

Every audiophile who has experimented with better AC power cables has heard the performance advantage they offer. Indeed, the amount of improvement can be astounding, often transforming a system from good to amazing. As audiophiles, we trust our ears but it's hard to understand how replacing just one short link in a long chain of the power delivery system can have such a dramatic impact. The following article is intended to answer those questions.

XLO has become a dominant force in the AC power delivery category. XLO's products have, in many ways, changed the way people think about AC power cables and raised the bar of performance. XLO cables have established themselves among audiophiles and industry professionals as state-of-the-art. The list of manufacturers and professionals that use XLO cables is impressive, to say the least.

XLO would like to address questions why using properly designed AC power cables can be such an influential addition to a system.

Introduction: "There are a lot of misconceptions about power transmission and power quality that make it difficult for some people to understand why an AC power cable makes a sonic difference. The first question is – do power cables make any difference at all? There is no sense in talking about theories of operation if we can't agree that there is an audible effect. Most of the thousands of people that use our power cables started out as sceptics and have answered that question for themselves and have found that power cables and power conditioners can have a profound impact on performance. And no – we do not care to debate with people that have not done the simplest of tests about whether power cords work or not. The only cases where a high quality cable does not have significant effects is when it is used with a poor quality power conditioner that acts as a high impedance to instantaneous current flow. "

Misconception #1: AC Power is like water coming from a large power tank, flowing through several tens of feet of power hose into a component. This implies that the component is at the end of this system.

Answer: Actually, the component sits between two power conductors: the hot and the neutral. AC power oscillates (alternates) back and forth at a 50-60 Hz rate. So power does not pour into the component at all. The component's power supply is within a complex network of wires and connectors. ALL of the wire and connectors can and do affect the performance of the component's power supply."

Misconception #2: AC power can be contaminated just like water in a hose. This implies that once the water is contaminated at some point up stream, that is must be cleansed before it arrives at the audio component.

Answer: As stated in #1, the component is not at the end of the power hose. It is between two power hoses and the current is oscillating back and forth. Further, current is not like water at all. Electrons cannot be contaminated. There are two aspects to power transmission: the electromagnetic wave and the current flow. The current itself cannot be contaminated but the electromagnetic wave can be modulated with other frequencies. We usually call these other frequencies noise or Electromagnetic Interference (EMI). Within the various parts of a power circuit there may be EMI in certain parts that is not present in others. Electromagnetic energy can be transformed or redirected to lessen their effects.

Some AC power cables use capacitors, inductors, or ferrites in an attempt to control the electromagnetic fields around the audio component. The success of such an approach is completely dependent upon the specific design and the reactance of the power supply of the component to which the power cable is attached."

Misconception #3: There is up to a hundred feet of wire in the walls, so the last six feet of power cable can't possibly make any difference.

Answer: The power cable is not the last six feet; it is the FIRST six feet from the perspective of the component. As stated in #1 the local current and electromagnetic effects directly affect the sonic performance of the component."

Misconception #4: There is a tremendous amount of electrical interference and EMI coming from outside the home that we need to protect our equipment from. This implies that we need some sort of power conditioner or filter to protect the equipment.

Answer: Most of the EMI that affects the audio quality of a system is generated by the audio components themselves. Electromagnetic waves that traveling through space dissipate in power at the square of the distance from the source. Furthermore, very high frequencies that propagate through the power circuit do not survive for long. Power lines present high impedance to high frequency (MHz and GHz) signals due to the relatively high inductance of power lines.

A primary source of audible sonic degradation is caused by the power supplies in our audio and video components. Most components use FWBR (Full Wave Bridge Rectifier) power supplies that generate an incredible amount of transient noise when the rectifiers switch off. The design of a power cable can significantly affect the reactance of these signals within the power supply. The power cable is effectively

part of the primary winding of the power transformer. The transition between the various metals used in a power cable and its connectors can cause electromagnetic reflections and diode-like rectification of the noise impulses as they propagate away from the power supply. If the power cable presents a high impedance to these signals they will be reflected back into the power supply where they will inter-modulate, thus increasing the high frequency noise levels of the component. Most power supply filters are ineffective at blocking very high frequency noise components and much of it is passed through to the DC rails. The sonic effects of this include: high background noise levels, blurred or slurred transients and a general lack of clarity and purity of the sound or visual image."

Misconception #5: There is some sort of conspiracy among audio designers that keeps them from producing a "proper" power supply that is not affect by power cable quality.

Answer: "This concept is like saying that if a speaker where properly designed, you wouldn't need to use a good quality speaker cable. XLO AC power cables have been tested with the most modest of mid-fi equipment and the most exotic state-of-the-art components. We have yet to find a component that cannot be improved by replacing the power cable.

As long as power supply design is based upon FWBRs or switching supplies, the power cord will always be significant."

Misconception #6: High-end power cables just increase the circuit capacitance acting as a high-frequency shunt.

Answer: There are some power cables that ARE designed this way. Some even insert capacitors within the cable to further increase capacitance. This approach has some positives and many negatives including the reactive interference with the way many power supplies are designed.

Capacitance alone cannot account for the differences in a power cable's performance. There are some high-end power cables that are very effective that have virtually immeasurable levels of capacitance. These cables are usually designed around hollow tubes with the conductors inside. The conductors are several inches apart and cannot significantly affect the capacitance of the power circuit."

Misconception #7: Power cables are just like speaker cables; always the shorter the cable the better.

Answer: Some speaker cable designers would argue that a speaker cable below a certain length is not better. We will let them address the issue if they desire.

A speaker cable conducts an audio signal from the power amplifier to the speaker. The distance is quite small, on the order of a couple of feet to several feet. The quality of a speaker cable is determined by how well it can transmit the signal from the amplifier to the speaker without alteration.

An AC power cable on the other hand is not transmitting a signal. It is conducting AC power and its sonic superiority will be determined by its ability to deliver current (steady-state and instantaneous) and its ability to deal with the EMI effects of the components to which it is attached.

Since a power cable is composed of a hot and neutral wire that the component sits between, a change in the length of the cable will increase the size of the "buffer" around the component. In general, we would not recommend a power cable that is shorter than three feet or one meter in length. But subtle degrees of audio performance are not the only consideration when putting together an audio system. Aesthetics is also important especially when the system is located in a beautiful home. It's interesting to point out the performance differences so that people can make an informed decision when determining the optimum length for their cables.

There is much more that can be discussed about power delivery but for the sake of brevity we will cut it short at this point. Like many of the manufacturers of high-end audio components, XLO design its products for the love of music and fidelity of music reproduction. There is a wide diversity of preference and subjective perception among individuals. Thankfully, there is also a wide diversity of manufacturers that create products to serve a variety of tastes.

Before XLO produced its first power cable, extensive testing of the audible effects of a variety of devices and materials associated with power transmission were conducted. XLO created many jigs and test apparatus to test wire types, dielectric materials, connector contacts, dampening materials and a variety of transformers, chokes, coils, ferrites, capacitors, triacs and diacs. After years of testing, XLO concluded that just about anything and everything that is inserted in or around the electromagnetic field of a power circuit has an audible effect. Some of the effects are quite small and are relatively insignificant. Others are dramatically profound and sometimes surprising in their behaviour. Without disclosing trade secrets by discussing all of its findings, there are some very basic observations that are worth sharing.

Firstly, wire type and size in a power cable is highly overrated. Every wire type (the metal itself) has a specific sonic characteristic. Silver, copper, brass, gold and others all "sound" different. The difference in sound is not related to conductivity capacity because XLO adjusted the sizes during testing to account for this. Each of the metal's inherent "sonics" can be ameliorated by careful adjustment of the other materials used in the construction of the final cable. XLO has an entire warehouse full of various prototype cables that never made it to production. Some of these use a

relatively small wire size of around 18 AWG that sounds surprising full in the bass. Intuitively, you might think that a small wire would sound thin in the bass region. This is not always the case. Conversely, XLO has some cables with wire as large as 1/0 AWG that sound powerful in the bass but are also flabby and irregular sounding. So, just increasing the wire size is not the easy answer that some might think.

XLO's "conclusions" are based upon observation through trial and error testing. Furthermore, there are no perfect components and there are no perfect parts. Everything is relative and the designer must weigh the sonic value of each part when designing a product. Its philosophy is to create a product that is a faithful musical component as opposed to striving for excellence in any single performance area.

Extensive testing with coils and chokes indicate that (in general, with exceptions) that any coil or choke that is placed in-line with the power circuit is harmful to dynamics. Many of them will also induce a subtle smearing or blurring of transients. This is naturally dependent upon the power supply design of the unit that the coil is used with. Coils and chokes are necessary in most components and "single layer wound" types such as the foil designs are preferred over others. Cost of production will always mitigate against the use of these types of coils due to the expense. This is why XLO does not believe in placing coils or capacitors within a power cable. These devices belong in the component or in a dedicated power conditioner.

Many components use a power inlet IEC that has an integrated "L" or "pi" filter. The quality of these devices varies dramatically. Generally speaking, the more capacitors and inductors that you have in a circuit, the more complex the dynamic interactions will be between the devices. This will also make the component they are used in more reactive and the possibility of negative sonic effects increase. Multiple filter networks can resonate and generate unintended results that have subtle but audible ringing or pinging sounds. Many of these IEC packages were created for office and computer products and are required to pass certification tests for EMI emissions. Generally speaking, what is good for a printer may not necessarily be good for a power amplifier.

Shielding can be a double-edged sword. On one hand, it can reduce radiated fields from impacting other components. On the other hand, the shielding may induce re-radiated fields onto the cable or component that it is being used in. Sometimes the cure may be worse than the illness. As always - you must know your materials and tools and apply intelligence with a small dose of intuition to create a world-class product. There is no silver bullet and there is no rote formula that works in all cases. There is just hard work, occasional inspiration and lots of testing."