White Paper

On the principles of design of

Chorale S RCA Stereo Interconnect

Designed from knowledge of the Laws of Physics

Engineered to give you maximum musical enjoyment

Hand crafted with attention to detail in Derby, England

Black Rhodium has supplying high quality audio cables to consumers for their home music playing systems for several years. Over that time Black Rhodium has been searching to improve the sound of their cables and has aided many innovative features in design.

Whilst examining all the possible ways to build the perfect cable, we realised that all the improvements we had achieved in sound quality could be explained by an understanding of the Laws of Physics. Not one Law, but several Laws that each influenced sound quality in different ways.

We asked the questions. Which Laws of Physics describe changes to electrical conductors that can change the sound played through the conductors.

And we detected 7 Laws of Physics that all could change the sound of music in a wire as it passed along a cable.

These 7 Laws of Physics are listed and examined in detail to understand exactly how music their effects distorted music.

For each Law, we devised engineering solutions that could minimise each of these effects and deliver a much more natural musical sound.

We then applied these engineering solutions to the design of Black Rhodium cables.

And built cables that gave great sound.

The 7 Laws of Physics that have an effect on your music.

1. All metals have their own molecular structure and they do not sound the same.
2. Wires cannot be manufactured with a perfect molecular structure.
3. Insulating materials absorb electrical energy when current flows in the electrical conductor and release it at a later time to cause a time-smearing distortion in music. This is known as dielectric absorption.
4. Some combinations of metal and insulation can generate electrical charges due to friction. This is the Triboelectric Effect and is a cause of microphony.
5. All cables can attract radio frequency signals which can modulate ad distort the electrical signal.
6. Magnetic fields, including those caused by adjacent wires, can change the flow of current through a cable and introduce noise.
7. Electrical fields generated from the electrical signal in a cable create mechanical forces between the wires. These forces induce mechanical vibration in the wires which modulate the electrical signal.

Having identified the Laws of Physics that describe how the electrical signal in a cable can be changed and musical enjoyment of a performance ultimately impeded, we now have to ask the question.

How do we minimise the effects of the Laws of Physics to prevent distortion;

We look at each of the Laws of Physics we have identified as influencing sound quality and minimise each effect separately.

1. All metals sound different.

All metals have their own sound and some sound better than others for playing music. At Black Rhodium we have auditioned many different metals. We have attempted to correlate the sound quality we hear with physical properties we can measure, but have found none.

There is a very strong correlation between what we hear and what we pay for the wire. The best sound quality we hear can only be delivered by the most expensive wires such as platinum, rhodium and palladium. Silver is more expensive than copper and in our experience does sound clearer. As high frequency sounds travel on the outer part of a wire, the application of silver-plated copper wires offer a cost-effective compromise of part of the benefits of silver wire at a fraction of the cost.

2. Manufacture of wire does not create a perfect wire.

All metals contain impurities and this affects sound quality. That is why cable suppliers often stress the low content of impurities in their conductors. Wires are made by drawing a cylinder of metal through smaller and smaller openings until they reach the desired diameter. The direction in which the wire is drawn affects its sound. For a stereo cable, the sound portrays a cleaner background between voices and instruments when the wires of both channels are drawn in the same direction from the same reel. The same applies to loudspeaker cables when the positive and negative wires are drawn in the opposing directions, and in power cables when the live and neutral wire directions are opposite. When wires are manufactured there are irregularities in the molecular structure that degrade sound. Deep Cryogenic Treatments relieve manufacturing stresses as the material cools and the atoms are more closely bonded together to remove distortion in the atomic structure.

3. Dielectric Absorption

An electrical cable requires insulation to prevent the electrical voltage connecting with other conducting materials or people. Insulating materials are not perfect insulators and all insulation materials will become electrically charged when there is a voltage difference between the wire and insulation. As the voltage reduces, electrical charges go back from within the insulation to the wire at a later point in time. In terms of the music signal, these charges are a noise that is added to the music, distorts the sound and spoils the music. For this reason, audio designers choose insulation materials for their low loss. A more advanced solution is to place the wire in a tube of much larger diameter than the wire so that the main dielectric is air.

4. Triboelectric effects.

Triboelectric effects or ‘microphony’ occurs when friction between certain pairs of conductor and insulation generate electrical charges. A conductive layer between insulation and screen reduces this effect.

5. Radio Frequency Interference

External radio frequency interference occurs when a cable can pick up radio waves and high frequency transient energy from external sources just as a radio aerial can pick up radio waves that are converted by demodulation into a radio programme of speech and music. The high frequency noise signals can distort music by modulating the audio signal and adding noise voltages. With the abundance of computers and other digital electronic devices, there is a lot of interference from which you need to protect your cable.

Radio frequency interference can be reduced both by screening the cables with a conducting screen or by inserting ferrite beads over the conductors.

6. Electromagnetic interference

The flow of electric current creates a magnetic field around the conductor. This magnetic field will affect the current flow in adjacent cables and add a noise voltage to the signal

transmitted. This noise voltage distorts music and impairs your listening. As the magnetic field reduces with distance, this effect will be less when cables are further apart. To minimise these effects a number of Black Rhodium cables have been manufactured with more insulation than required so as to increase the distance between conductors. In practice these cables did produce a smoother and more relaxed sound than cables with thinner insulation and have won several awards for sound quality.

All audio cables need to be protected from not only from adjacent current carrying wires, but also from external magnetic fields by external screening.

7. Vibration

Micro- vibrations within conductors in a cable can generate audible distortion to music. These can be reduced by the inclusion of damping materials within the cable and also by mass damping via vibration stabilisers. Both solutions reduce distortion in music.

Engineering solution to reduce audio distortion

From detailed study of each of the Laws of Physics that applies to audio cables, Black Rhodium has devised several different engineering solutions that can be applied to cables at all levels of performance and price.

Some of the solutions have only emerged after very extensive testing of materials and a lot of searching.

Black Rhodium Chorale cables use:

1. The very best conductor wires consistent with the price level they serve.
2. Deep Cryogenic Treatment of signal wires and quality control processes on wire direction during assembly to ensure optimum sound.
3. The very best dielectric materials chosen by sound quality for their lack of distortion.
4. Materials known not to cause friction induced charges to avoid microphonic effects.
5. High performance electric screening materials and ferrite high frequency filter beads as appropriate.
6. Construction and assembly techniques that protect not only against magnetic fields from adjacent conductors, but also from external fields.
7. Vibration damping materials along the whole length of the cable.

Black Rhodium Chorale cables are hand crafted at the Black Rhodium factory in Derby, England using innovative new techniques developed by Black Rhodium engineers in conjunction with traditional electrical design techniques.