

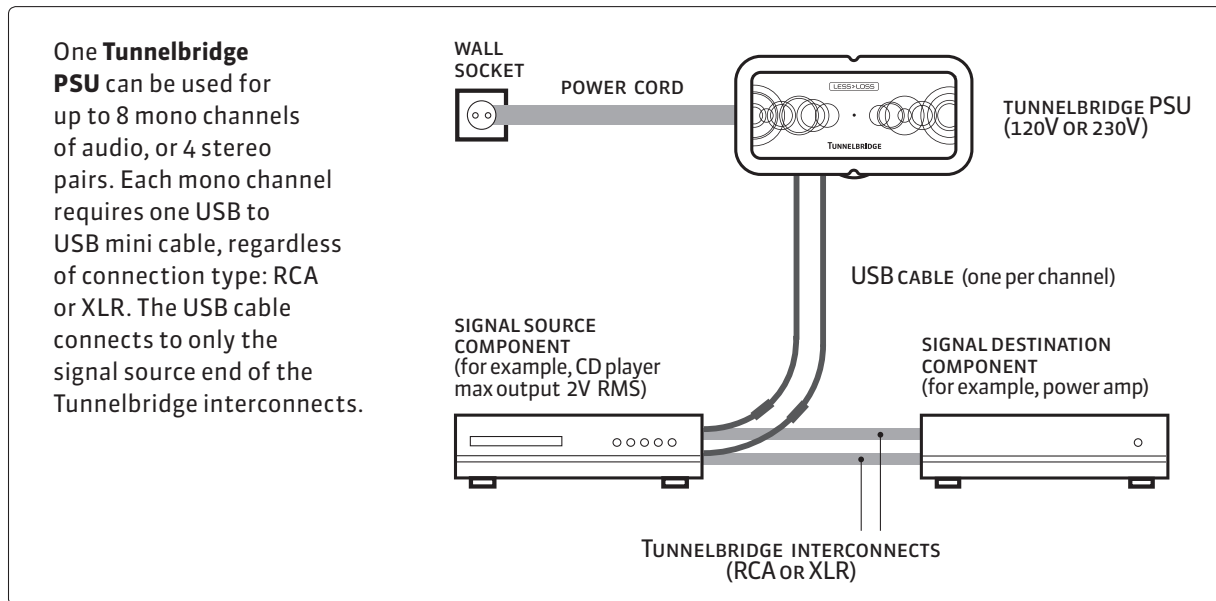
Tunnelbridge

RCA AND XLR DISTORTIONLESS INTERCONNECT SYSTEM

The **Tunnelbridge** is our innovative solution for dealing with the inevitable distortions of interconnect line level signals. Distortion is always born by the passing of such a signal through an interconnect cable. In the **Tunnelbridge**, this distortion is not taken away; rather, it is moved to a location within the cable which is known to have no influence on the quality of the passing signal. This is achieved through a combination of associated electronics and a special configuration of the **Tunnelbridge** circuit within the cable. This is explained in detail below.

The system How to install it

The **Tunnelbridge** system is comprised of a stand alone Power Supply Unit, the **Tunnelbridge** interconnect cables, and USB to USB mini umbilical cables, which connect the PSU to the interconnects to complete the Tunnelbridge circuit.



The problem Action and reaction

Typical interconnect cable designs with an aim to facilitate high quality signal transfer can only achieve this in a reactionary way. Any damping solution for undesirable microvibrations is achieved through a variety of electromagnetic signal and material interactions. These include nuances of metallurgical mixtures, cable geometries, select insulator materials, and shielding solutions. Each element interacts with all others, making the art of high end interconnect design an intriguing and complicated affair. The initiator of these reactions is the signal itself, which comes into the equation first.

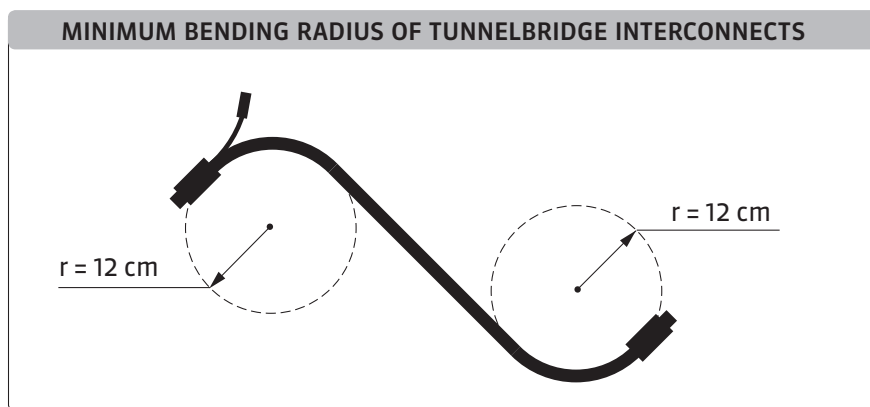
The premise Reactive control is too late

There is no getting around the fact that, by the time the damping of undesirable microvibrations takes place, the harm has already been done. One may have heard of the famous cable design issue described as “overdamping the sound.” Its very description using this term shows that this is not the best path to take. In fact, we have exactly no time to deal with microvibrations once they have occurred. From that point on, they have resulted in altered signal.

The sources of distortion are many. Everything in a cable influences the sound to some degree. The entire history of audiophile interconnect design has largely been centered upon mixing and matching different materials and processes to create what may be deemed a best mixture, a best recipe, or a sound which can “fit a system”. However, some coloration of the sound always remains. The LessLoss **Tunnelbridge** is a true solution to these signal coloration problems, which goes fundamentally to their source, and solves them directly, as they are arising, not afterwards in a reactionary way. Therefore, it solves the problem, instead of offering yet another “beautifully colored” solution, allowing the problem to persist.

Flexibility How it looks and feels

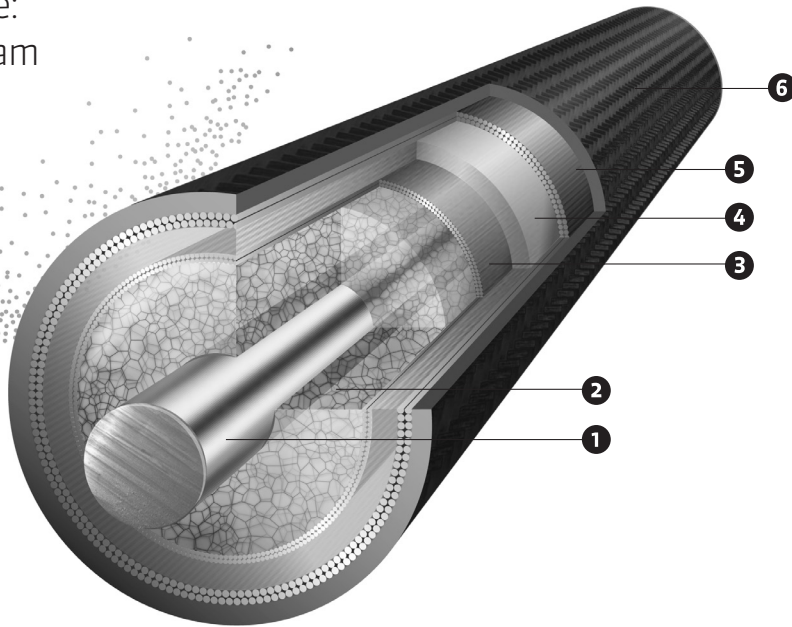
There are over 40 parts within a two-channel **Tunnelbridge** system. These are intricately hand crafted cables which contain embedded electronic components. Although the cables are very flexible, we offer a minimum length of 1.5 meters to ensure that in their installation, smooth arches can be maintained, and no sharp bends or angles would be needed. As with any high quality interconnect, these should be treated with care. They are not intended for industrial stage work and should never be stepped on or dealt with in a rough manner.



The architecture What's inside

LessLoss Tunnelbridge: Cross Sectional Diagram

Dual concentric shields around a solid silver core conductor make up the main architecture of the cable itself. The rest of the **Tunnelbridge** system is comprised of a stand-alone Power Supply Unit and a USB to USB mini umbilical cable, joining PSU to **Tunnelbridge** interconnect.



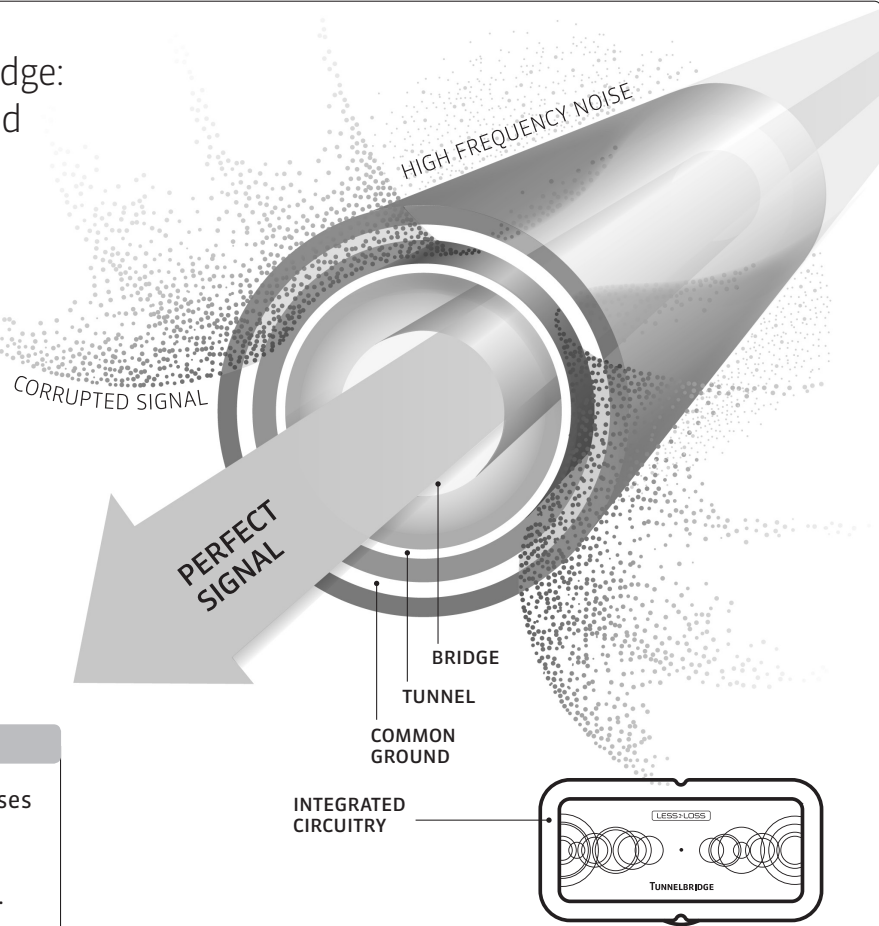
- FEATURES**
- Active electronic control system
 - Outboard PSU
 - Preemptive microvibration control
 - Not passive and reactionary like traditional cables
 - Very low resistance; solid silver core
 - Non-capacitive, non-inductive shielding
 - Diameter:
RCA: 7.1 mm, XLR: 14.2 mm

- 1 Pure silver mono core, soft annealed. 20 AWG (0.5 mm²), per phase for XLR.
- 2 Neutral polyethylene foam insulator. No color agents added.
- 3 Silver plated copper shield, braided, 100% optical coverage. Clusters angled at 45 degrees, 192 strands total.
- 4 Moisture resistant ultraviolet treated clear polyvinyl chloride insulator. No color agents added.
- 5 Corrosion resistant tin plated copper shield. 95% optical coverage. 192 strands, 11 AWG total (4.15 mm²).
- 6 Abrasion resistant Polyethylene Terephthalate outer shell, cross braided.

The principle How it works

LessLoss Tunnelbridge:
Good and corrupted signal paths

The signal is electronically cloned in real time, and is fed into a separate circuit called the **Tunnel**. The cloned signal in the **Tunnel** absorbs all naturally occurring corruption; then, is discarded. The perfect signal, entirely unscathed, exits through the circuit called the **Bridge** into the interconnected audio component.



PERFECT SIGNAL

Only perfect signal passes through the **Bridge**.
Only this signal passes to the destination gear.

This signal sees:

- no skin-effect related eddy currents
- no capacitance
- no memory effect

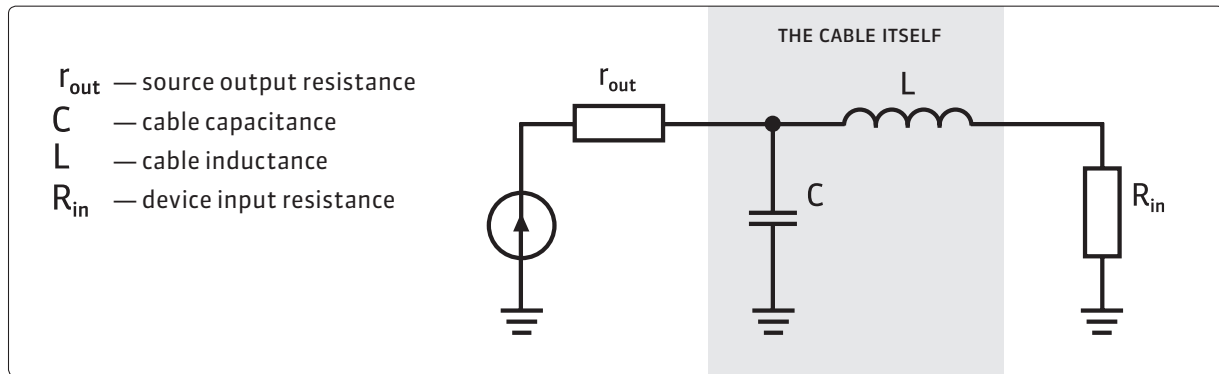
CORRUPTED SIGNAL

Tunnelbridge integrated circuitry captures the corrupted signal from the Tunnel, which has undergone the influence of:

- electric and magnetic field interactions
- eddy currents
- capacitance
- memory effect

The wrong theory Lumped parameters

What exactly is, in electrical terms, a simple, traditional audio interconnect? If we can't answer this accurately, we cannot know whether we are making progress. It is often held that an audio interconnect has only a negligible capacitance **C** and inductance **L**, because the output resistance of the audio signal transmitter is relatively low, and the input resistance of the signal input receiver is relatively high. If we model an interconnect as a set of lumped parameters [1] (in other words, a low pass filter), the equivalent schematic of such a cable connected to the audio gear looks like this:



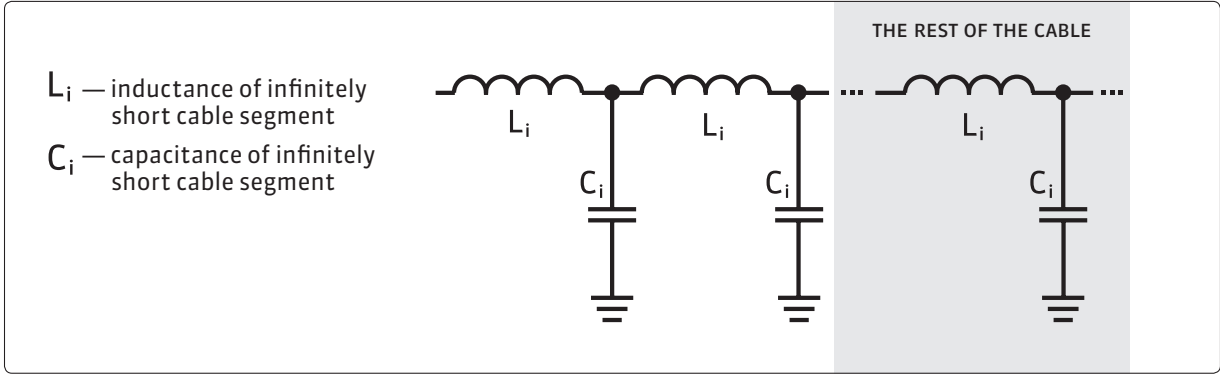
Further arrogance Hey, it all works on paper

Because the resistance of the cable itself is so much smaller than the output and input resistances of the gear, we choose to discount this resistance of active loss, and we simply add it to the gear's resistance. Why? Because the electrical resistance of a cable is many orders of magnitude smaller than even the normal dispersion of 100k Ohm resistors incurred during manufacturing, which, in the best of cases, are manufactured to only a +/- 1% tolerance of accuracy, and nobody hears or can hear this amount of deviation.

The bandwidth of such a schematic, influenced by its capacitance C , is equal to $f = 1/2\pi r_{out}C$. And, influenced by its inductance L , is equal to $f = R_{in}/2\pi L$. Supposing a typical cable capacitance value of $C=100\text{pF}$ and $r_{out}=100\text{ Ohm}$, then f , the bandwidth passed by the cable, is about 15 MHz. Therefore, any typical cable, according to this model, should pass an audio signal from component to component without any noticeable differences. Right?

Wrong Let's try another model

If we consider a cable as a distributed series of small inductances and capacitances, which is what it in fact is, because it has a length, the more accurate equivalent schematic now looks like this:



Here, L_i and C_i correspond to infinitely many inductance and capacitance values at infinitely small lengths of the cable [2].

The characteristic impedance of such a cable is defined as: $z_o = \sqrt{L_i / C_i}$

Wrong again Not a perfect match

If we connect such a cable into a system whose source and receiver were both also of this equal impedance, we would have a matched [3] line, in which we would theoretically not perceive distortion of frequency response nor of impulse response. However, there is no official standard of implementing matched lines in home audio line signal applications. As a rule, the output impedance is made to be low, and the lower the better. The input impedance is made to be high, and often times, the higher the better. The aim of this is to create the best conditions for the first model we mentioned above, as a set of lumped parameters. These models are clearly insufficient to explain the design merits of true high performance audio interconnects. In other words, you can still hear the difference between cables.

And There's a huge resonance

In a transmission line model, the source signal is introduced into the input end of the cable, and the other end is said to be "open." This represents, in effect, a quarter wave resonator ($\lambda/4$) or stub [4]. It is often overlooked that this creates a very profound resonance at the frequency whose wavelength is about four times as long as the length of the cable. For example, if the cable is 1m in length, this large resonance will be around 75 MHz.

The memory effect Let's not forget

One other aspect which is often overlooked when describing the effect of an interconnect cable on sound quality is the spontaneous electric polarization or “memory effect” of the dielectric material situated in the electric field within the cable [5]. This effect is often taken into consideration when investigating the influence of capacitors on sound quality. We can notice and measure this effect by carrying out the following simple experiment.

First, charge an electrolytic capacitor, then fully discharge it by shorting its two leads for a few seconds. Unshort the capacitor and then quickly measure the voltage across the capacitor. What you'll see is that the voltage is at first zero, and then quickly begins to rise. The capacitor seems to “remember” that it was recently charged. Of course, a good capacitor should not exhibit such behavior.

Detailed studies have shown that this effect is not limited specifically to electrolytic capacitors. Any capacitor whose dielectric material's dielectric constant ϵ is substantially larger than 1 portrays this effect, and, as it turns out, the larger the dielectric constant ϵ and, therefore, the larger the electric field inside the capacitor, the greater this memory effect [6]. Because a cable is in this regard a capacitor (simply unrolled), the same holds for loss of signal quality in cables. When the signal is no longer present at the cable source, it can “show up” somewhere in the cable at a later time. It is no wonder, then, that manufacturers of high quality cables emphasize the importance of the quality of the chosen dielectric material.

You can't remove distortion But you can move it

The architecture of the **Tunnelbridge** is that of a coaxial cable with two concentric shields. The signal is fed into the center conductor and the outer shield is the “ground”. The middle shield receives the same signal as the center conductor through a voltage unity gain buffer circuit. The buffer's function is to protect the signal in the center conductor from loss and distortion arising from capacitance between itself and the outer shield. Because there is never any voltage potential between the center conductor and the middle shield, there is also no electric field there. If there is no field, there is no capacitance; nor is there any spontaneous dielectric polarization. Thus, we have tackled the “memory effect.” The signal, without having been exposed to the electric field, now makes its way through the cable into the input socket of your destination gear.

We experimented with this concept and heard clearly that it works very well. Then we took it one step further. Where we first obliterated the capacitance of the center conductor to the ground by compensating the electric field there, we now managed to compensate the center conductor's magnetic field as well. This aspect of our final circuitry design was the most difficult to achieve. As a result, the center conductor now has no magnetic field, which means that it also has no inductance. Eddy currents which normally give rise to distortion now no longer affect the good signal in our “Bridge,” because they are located on the far side of our “Tunnel.” There is never any voltage potential between the Tunnel and Bridge. But we only listen to the signal from the Bridge, which is located inside of the Tunnel, protected from these otherwise inevitable distortions.

After many experiments with electromagnetic field simulation software, real cable models, and many audiophile systems, the results achieved surpassed our wildest expectations. It turned out that our theoretical model proves itself in practice. There was an obvious difference in sound quality when comparing the **Tunnelbridge** with traditional interconnect cables made with identical materials. When a cable's dielectric is not influenced by both electric and magnetic fields, its behavior is electromagnetic neutrality, meaning non-influential to the signal in the center conductor, which never experiences capacitance or inductance in this design.

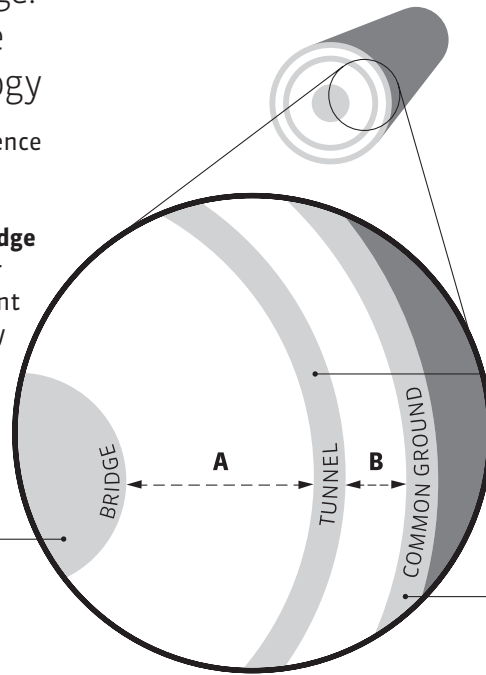
The physics Why it works

LessLoss Tunnelbridge: Concentric Duplicate Signal Field Technology

Known locations of the presence and absence of capacitance and electrical fields lie at the heart of the **Tunnelbridge** distortionless signal transfer solution. Via dual independent signal circuits, one knowingly good, and one knowingly corrupted, we achieve distortionless signal transfer.

This is the Bridge

It carries the original, good signal only. This signal shall pass the system without change. Only this signal exits past the cable system into the destination gear at the other end of the **Tunnelbridge** interconnect.



This is the Tunnel

The **Tunnelbridge** integrated circuitry feeds an independent clone of the good signal into the **Tunnel**. The **Tunnelbridge** concentric duplicate signal field technology guarantees that in real time, zero voltage potential is always maintained between **Tunnel** and **Bridge**.

This is the common ground for both **Tunnel** and **Bridge**, serving also to shield the entire **Tunnelbridge** dual concentric cable assembly.

A THE UTOPIAN FIELD CONDITIONS

- never any voltage potential
- never any electric field
- never any capacitance
- never any memory effect

B THE LOSSY FIELD CONDITIONS

All losses occur and are confined here, affecting only the **Tunnel** signal. These are discarded by the associated **Tunnelbridge** circuitry.

THE BRIDGE

The **Bridge**, the good signal, is: (1) tricked into thinking that the ground is infinitely far away, and (2) not distorted by eddy currents, because there aren't any here. They are all on the other side of the **Tunnel**.

THE TUNNEL

The **Tunnel**, carrying the clone signal, has been put forth to collect all distortions arising from capacitance and eddy currents, which are then discarded by the **Tunnelbridge** integrated circuitry.

Justified caution I still don't like it

Q: Isn't a cable supposed to be completely passive? How about the dangers to pristine sound quality brought forth by the inclusion of active electronics in the Tunnelbridge?

A: There is no direct influence, because the signal which reaches the input of your gear never encounters the circuitry in the **Tunnelbridge**. And the signal in the **Tunnelbridge** which does encounter this circuitry never makes its way into your gear. The only function of the circuitry is to obliterate both the cable's capacitance and inductance which would normally affect the signal.

Let's put some numbers on it. If, for example, the **Tunnelbridge** electronics would cause a 0.01% distortion of the Bridge signal, then it would not cause a 0.01 % distortion of the system; it would only cause a 0.01 % rise in capacitance and inductance in the cable when compared to no cable at all.

We want to emphasize that we respect your audio signal's integrity the way the designer of your gear envisaged it. We assume from the outset that the signal which is introduced by your gear into the **Tunnelbridge** is ideal. Even though the **Tunnelbridge** is a powered audio interconnect, it does not amplify, correct, influence, nor in any way “beautify” the signal it passes. The function of the electronics associated with the **Tunnelbridge** is merely to create ideal conditions for the signal to pass, completely unchanged, into the next piece of gear. Without the associated electronics, the cable functions as any other high quality interconnect.

FOOTNOTES AND REFERENCES FOR FURTHER READING

[1] Lumped parameters are a simplification in a mathematical model of a physical system where variables that are spatially distributed fields are represented as single scalars instead.

For more see http://en.wikipedia.org/wiki/Lumped_parameters

[2] The Telegraph Equations are from the 1880s. For more see http://en.wikipedia.org/wiki/Telegrapher's_equations

[3] For more see http://en.wikipedia.org/wiki/Transmission_line

[4] In microwave and radio-frequency engineering, a stub is a length of transmission line or waveguide that is connected at one end only. The free end of the stub is either left open-circuit or (especially in the case of waveguides) short-circuited. For more see [http://en.wikipedia.org/wiki/Stub_\(electronics\)](http://en.wikipedia.org/wiki/Stub_(electronics))

[5] Ferroelectricity is a spontaneous electric polarization of a material that can be reversed by the application of an external electric field. For more see: <http://en.wikipedia.org/wiki/Ferroelectric>

[6] It can be noted here that the trend towards the miniaturization of electronics during the past half century has been made possible largely by extensive R&D into new materials with ever higher ϵ values.