Hitachi Cable America Inc.

Category Cable Shielding Basics

Comparing Unshielded and Shielded Cable Designs

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Shielding basics and performance – Comparing UTP and Shielded Cable designs

A cable shield provides a protective barrier from external electrical fields around the cable. The shield, a conductive metallic foil with a polyester backing, surrounds the cable pairs and helps prevent extraneous voltages from influencing the signal on the pairs beneath the shield layer. Image 1 illustrates how external electrical fields interact with an unshielded twisted pair cable (UTP) and a twisted pair cable with an overall shield (F-UTP). The shield on the F-UTP cable actually causes the electrical fields to bend around the cable such that the voltage at the surface of the shield is practically at ground potential. The amount of external field energy within the shield is essentially zero. By contrast, the electrical fields surrounding a UTP cable penetrate the jacket and directly interact with the pairs. Without a shield, only the pair twist and pair balance help offer immunity to the noise.

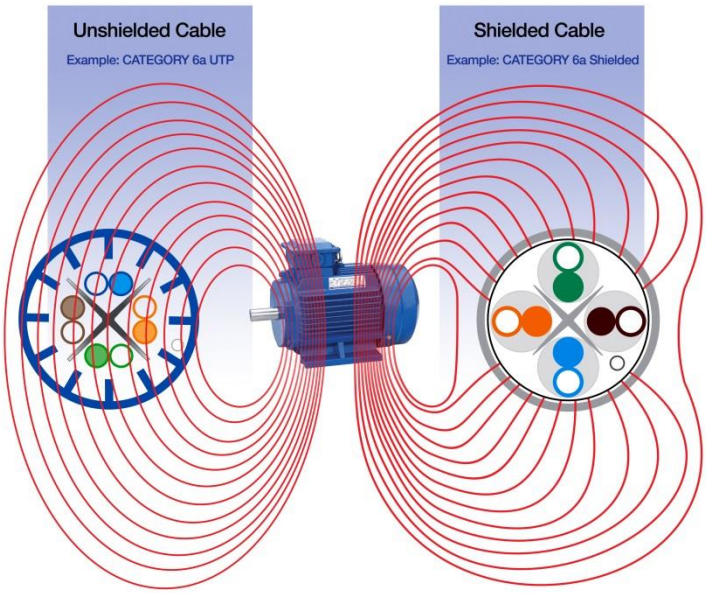


Image 1.

Industry standards such as ANSI/TIA-J-STD-607-B provide requirements for bonding and grounding of a telecommunication infrastructure. Bonding and grounding are a critical component of any telecommunications infrastructure. The standard was established to ensure that the telecommunications infrastructure will have only one electrical ground potential. Different ground potentials can occur when a ground in part of a building is of a different voltage than that of another part of the building. This situation can then result in unwanted voltage on a circuit, also known as a ground loop. This unwanted voltage can impact network equipment by disrupting video signals, corrupting data transmissions, and, if significant enough, pose an electrical shock hazardous to users.

What is most significant about this standard is that the requirements for bonding and grounding are the same regardless of whether the infrastructure utilizes shielded or unshielded cables and connectivity. It is not the case that if you install an unshielded network solution that you do not have to take bonding and grounding measures. With the large variety of bonding and grounding devices available on the market, bonding and grounding has never been easier.

Internal Noise: Balance & Crosstalk

Internal noise in a cable is generated by minor aberrations in the twisted pair causing reflections within the cable, and coupling of energy from one pair to another. The interaction within a cable strongly depends on the pair balance and the design of the twist lays for the cables. The twisting of the pairs is intended to

"average" the electrical field around the pair such that the average field around the pair is greatly reduced. Cables are designed to be perfectly balanced so that the current in each wire is equal and opposite (Image 2). This makes the "net current" zero. However, not all cables are created equal. Cables of higher quality that are tested to a higher standard will provide less internal noise and, therefore, deliver better performance.

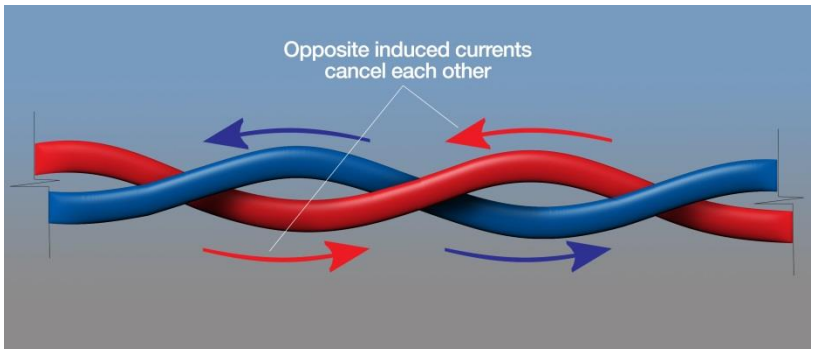


Image 2.

However, even a perfectly balanced pair does not cancel all of the unwanted electrical noise along the pair. Crosstalk, which is unwanted pair to pair noise, return loss, and signal reflection, also contribute to a cable's internal noise. The twisted pairs in a category cable have a significant amount of energy that extends beyond the perimeter of the pairs. This is unavoidable, and exists in any twisted pair no matter how balanced the pair is built or how perfectly the insulated conductors are made.

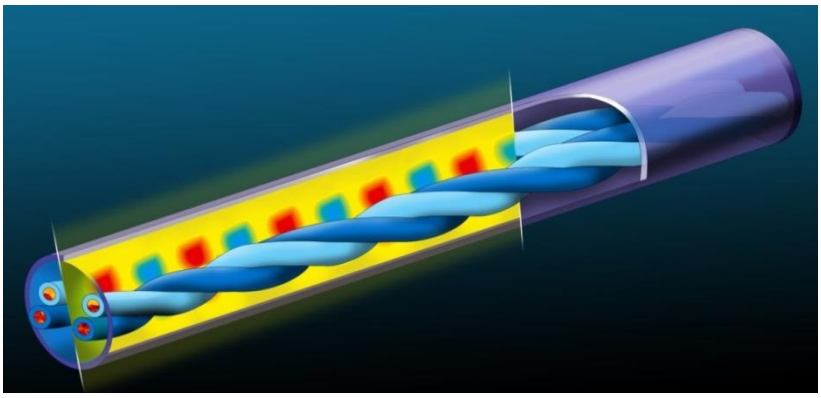


Image 3.

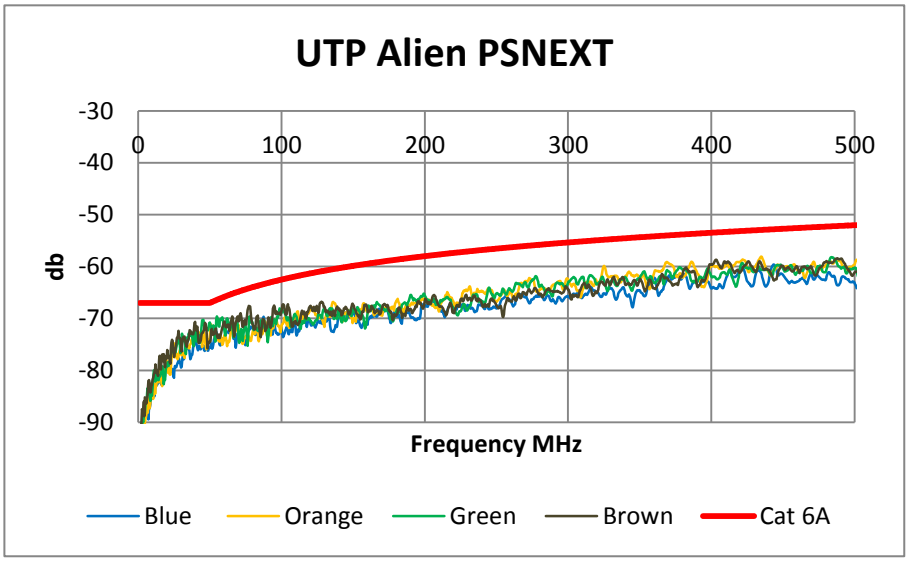
Image 3 below shows the electrical field interactions between adjacent pairs or to a cable shield. The blue and red regions highlight the areas of stronger electrical field interactions, whether positive or negative in polarity. Interactions are minimized with improved balance and pair construction, but are never eliminated.

External Noise: Alien Crosstalk & Coupling Attenuation

Imperfections in the pair construction tend to strengthen the energy surrounding the pair and increase electrical noise emanated from that pair. This noise negatively impacts the performance of adjacent pairs and helps contribute to Crosstalk. While pair to pair noise within a cable is referred to as Crosstalk, noise from adjacent cables is referred to as Alien Crosstalk. All categories of UTP cables, due to their designs, have a relatively significant amount of Alien Crosstalk. However, it was only with the introduction of higher throughput applications, such as 10 gigabit Ethernet that Alien Crosstalk has become an issue. For this reason, Alien Crosstalk is included as a Category 6A test parameter in the latest telecommunications infrastructure standard, TIA-568-C.

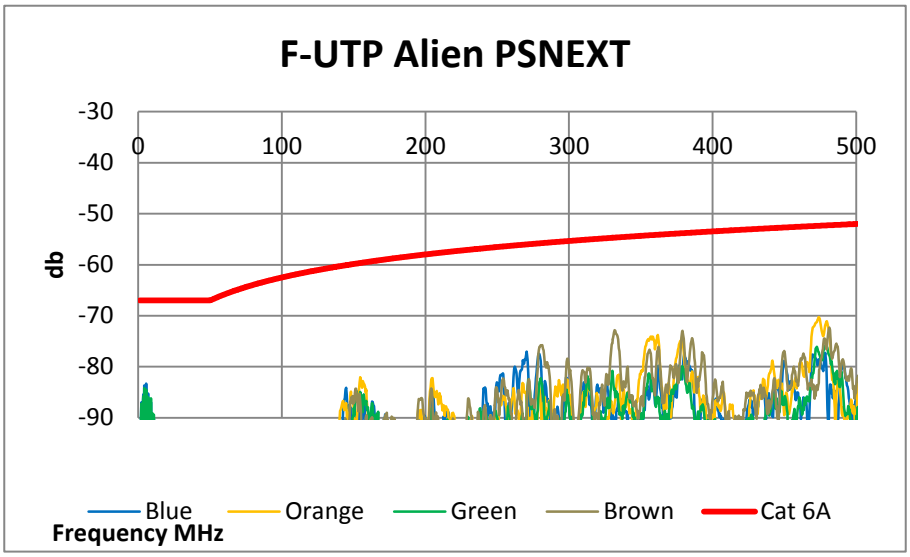
Alien Crosstalk testing was established to measure the crosstalk that results from one cable to another. However, a mix of lower cable category types may not meet alien crosstalk requirements when in close

proximity to a Category 6A cable. Since Alien Crosstalk is not measured for these cables, it is unknown how much of an impact their noise may have on other cables, including Category 6A, and, likewise, what impact the noise from the Category 6A cable will have on them. Laboratory tests for Alien Crosstalk test the noise immunity of cables from the noise generated by other cables, but not for all types of external sources. For better isolation from all external noise sources, a fully shielded infrastructure is ideal.



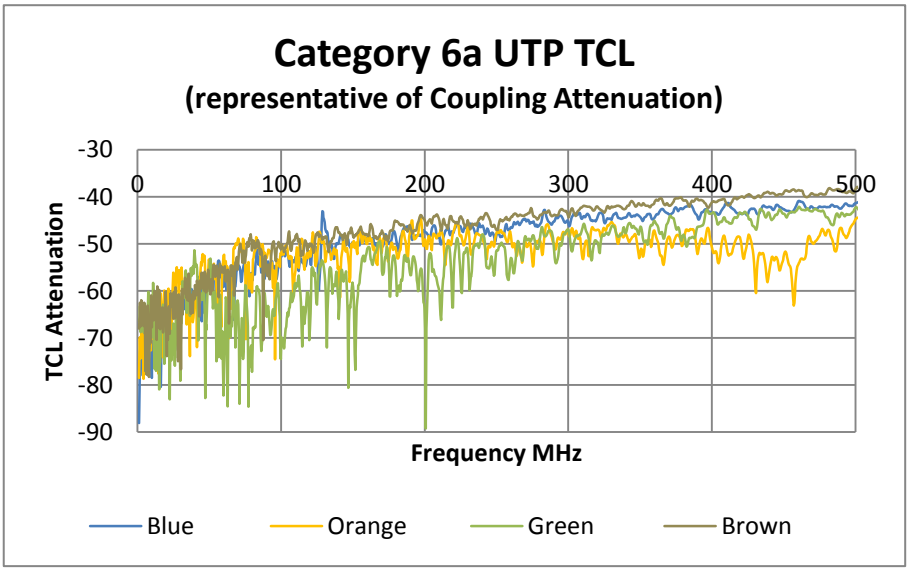
Graph 1.

Alien crosstalk measurements for UTP (Graph 1) and F-UTP (Graph 2) reveal a significant difference in the noise immunity between the two cable designs. Though the test requirements for Category 6A do not discriminate between shielded or unshielded designs, testing has shown that F-UTP designs perform much better. So, a cable with a shield will perform better when it comes to external noise, regardless of whether that noise emanates from other Category 6A cables or other external noise sources.



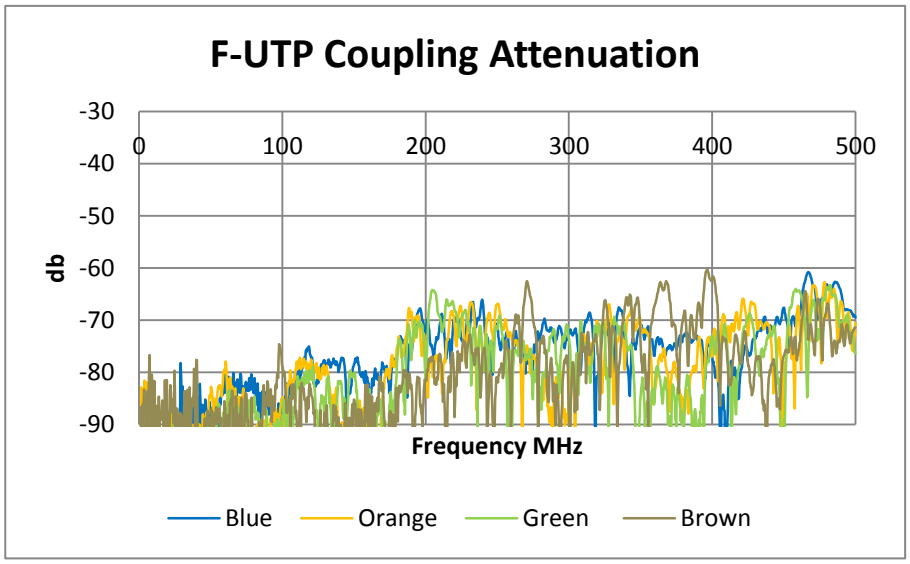
Graph 2.

Another key measure of the effectiveness of isolation from external noise environments is Coupling Attenuation. Coupling Attenuation can be used as a more representative measure for isolation from all external noise sources, not just those from adjacent cables. For UTP cables, the coupling attenuation measurement is another way of measuring the balance of a cable (Graph 3). Measurements of TCL (Pair balance) for UTP cable provide a good approximation of the coupling attenuation.



Graph 3.

Coupling attenuation is a measure of the reduction in noise on the pairs from outside noise sources. A full metallic shield has a high level of coupling attenuation, thus provides a quiet environment for the pairs within the cable.



The test results highlight the significant differences between the coupling attenuation for F-UTP and UTP cable designs. Since attenuation is the reduction in signal strength, a cable that demonstrates higher Coupling Attenuation means it does a better job of getting rid of outside noise. As demonstrated in Graph 3 and Graph 4, an F-UTP cable with its bonded and grounded shield provides much better levels of coupling attenuation and greater immunity to external noise than an UTP cable.

Summary

A fully shielded cable, using modern readily available components, provides a reliable robust solution in which the cable core is well isolated from external noise sources. Shielded cables offer excellent Alien Crosstalk, high levels of Coupling attenuation, and a design that results in the most noise free environment for the pairs within the cable.