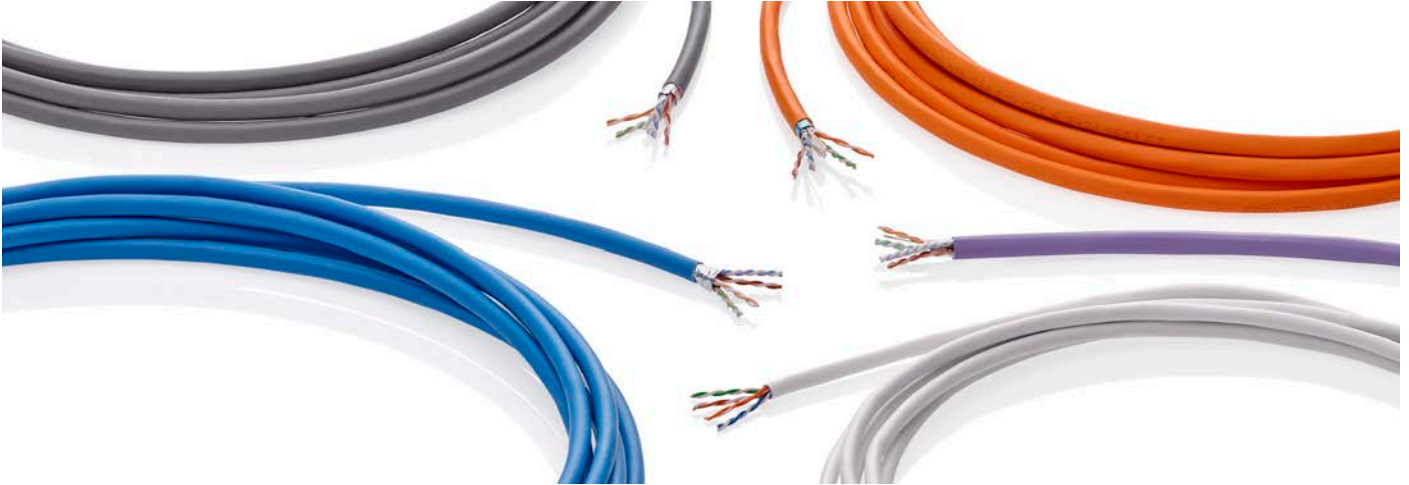


WHITE PAPER



Performance Benefits and Advantages of Leviton SST Cat 6A Cable

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SUMMARY - PERFORMANCE BENEFITS OF SST CAT 6A CABLE

Introduction

Cat 6A is currently the preferred category of Ethernet cable for future-proofing cabling installations and achieving reliable 10GBASE-T networks. Deciding on a suitable Cat 6A cabling solution requires consideration of multiple factors, including ease of installation and performance factors such as Alien Crosstalk (AXT). This paper identifies the advantages of choosing Leviton's SST Cat 6A cable, which uses an EMI Isolation Wrap construction. We shall compare the performance benefits of the SST cable against the other three main Cat 6A cable constructions available on the market, as shown in Table 1 below.


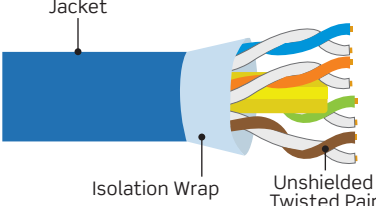

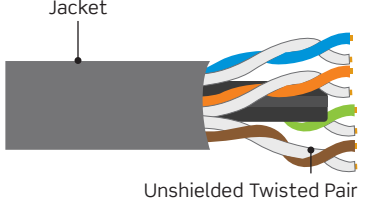

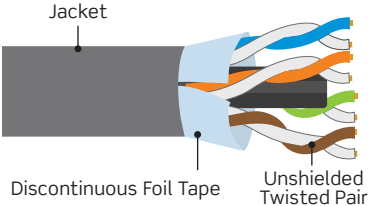
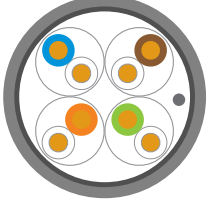
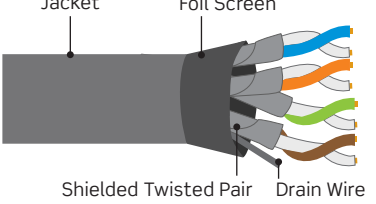
CABLE CROSS SECTION	DESCRIPTION	CABLE DRAWING	DESCRIPTION
	SST Cable with EMI Isolation Wrap		<ul style="list-style-type: none"> • Continuous Isolation Wrap • Nonconductive surfaces on both sides of the isolation wrap • No drain wire
	Traditional U/UTP Cable		<ul style="list-style-type: none"> • No foil tape or isolation wrap • No drain wire
	Discontinuous Foil Tape U/UTP Cable		<ul style="list-style-type: none"> • Segmented isolation wrap used • Nonconductive surfaces on one or both sides of the isolation wrap • No drain wire
	Shielded Cable		<ul style="list-style-type: none"> • Metallic foil and/or metal wire screen • Cable has a drain wire

Table 1 - Typical Cat 6A Cable Constructions

CAT 6A TRADITIONAL U/UTP CABLE

Cat 6A traditional unshielded twisted pair (U/UTP) cable is constructed to reduce alien crosstalk (AXT) to acceptable levels in tight bundles. AXT is defined as the unwanted signal coupling from one balanced twisted-pair component onto another. Figure 1 to the right shows an example of how AXT can occur where multiple cables (disturbers) surround another cable (disturbed or victim) and couple electrical noise onto it.

Minimizing electrical performance degradation due to AXT amounts to the biggest challenge in the design and installation of a traditional U/UTP cable. The cable design must have electrical compliance to all relevant standards while installers must ensure that it is installed using proper installation practices. For traditional U/UTP cable, typical design approaches include tighter pair twist rates for improved intra-pair balance and

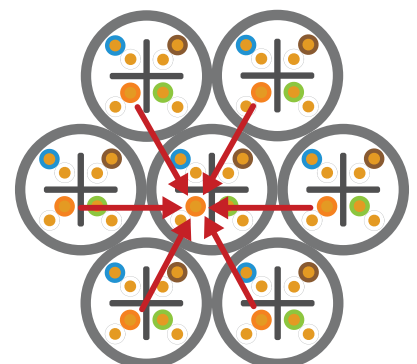


FIG. 1 - 6 AROUND 1 ALIEN CROSSTALK (AXT)

therefore better inter-pair noise immunity. Larger copper conductors are required to compensate for the reduction in insertion loss margin caused by the additional length from the tightly twisted pairs.

Increased airspace within the cable is also used to help reduce crosstalk, usually through the inclusion of an internal separator or cross-filler between pairs and typically a thicker outer jacket wall. Both the requirement for larger copper conductors, and for increased internal airspace, lead to traditional U/UTP cables designs having larger outer diameters. The larger outer diameter is needed to ensure a greater distance between the pairs in adjacent tightly bundled cables, to reduce alien crosstalk, and meet the Cat 6A standards requirements for PS ANEXT and PS AACR-F.

TRADITIONAL CAT 6A U/UTP CABLE CHARACTERISTICS	
Design Features	Trade-Off
Tightly twisted pairs	More time required to untwist and terminate / Heavier cable
Increased internal air space	Larger cable diameter / More installation space required / Poorer fire performance
Thicker jacket wall / striated internal shape	Reduced flexibility / Larger cable diameter
Increased cable outer diameter	Reduced flexibility / More installation space required / Reduced airflow

Table 2

Challenges during installation of traditional Cat 6A U/UTP include the larger outer diameter of the cable and larger bend radius which, in turn, requires more pathway space. The increase in containment space will lead to higher installation costs due to the requirement of potentially larger trays/baskets or higher quantities of trays/baskets. The larger cable bundles also reduce airflow, leading to increased temperature rises which become detrimental to system performance if not properly controlled and therefore additional cooling may also be required. This is particularly important in structured cabling systems that are providing Power over Ethernet (PoE) where PoE further increases the heating effect in the copper conductors. In some cases, designs incorporating larger cables may need to be restricted in channel length to prevent overheating.

Alien crosstalk (AXT), which is the most significant design challenge for traditional Cat 6A U/UTP, can also prove difficult for any DSPs (Digital Signal Processors) in active equipment to correct and as such can lead to compromised signal integrity. Susceptibility to external noise from other sources such as power cables, electric motors, or Wi-Fi transmitters can also become an additional issue with traditional Cat 6A U/UTP cables and requires careful consideration during and after installation.

Even using best practices for design and installation, traditional Cat 6A U/UTP cable ultimately remains negatively impacted by AXT and thus the ISO/IEC and TIA standards bodies require Cat 6A U/UTP cables to be tested for both PS ANEXT (Power Sum Alien Near-End Crosstalk) and PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio, Far-End) as a component base cable as well as installed links and channels. This can be costly and time consuming. AXT margins above ISO/IEC and TIA limits for this type of cable during testing are typically low and subject to many variables including the physical layout of the overall length, cable manufacturing tolerances, as well as electrical phasing variation of adjacent cables. While lab testing or independent third-party certification, including 6-around-1 alien crosstalk measurement, can give some assurance of performance, it is not always reflective of potential worst-case scenarios that may be encountered in real world installations. This is one area where shielded cables have a performance advantage over traditional U/UTP cables. The alien crosstalk testing requirement is generally unnecessary for shielded cables, which are deemed to meet such requirements by design if cable coupling attenuation is better than the minimum Type II stated in the IEC 61156-5 standard.

AXT measurement is regarded within the cabling industry as the best test method to ensure networks integrity within 10GBASE-T cabling when in the presence of EMI. Therefore, AXT is a key requirement for 10GBASE-T cabling. Achieving the highest possible margins for PS ANEXT and PS AACR-F allows for higher confidence levels in uninterrupted data transfer after installation.

Advantages – SST Cable Over Traditional Cat 6A U/UTP Cable

Leviton SST Cat 6A U/UTP Cable has an added layer of protection by way of a continuous isolation wrap to reduce unwanted electrical noise coupling into and out of the cable. This enhances the twisted pairs' signal integrity and allows for the removal of some of the previously highlighted design constraints of traditional Cat 6A U/UTP. The overall cable diameter and jacket thickness are reduced to allow for larger cable bundles, improved flexibility, and better airflow. Cable pair twist rate is also reduced and precisely designed to maximize performance using Leviton's unique precision twist technology in the cable's manufacture. Leviton SST's reduced twist rate allows for easier and significantly faster termination into jacks as well as providing a reduction to the cable weight for easier handling during installation.

The addition of the isolation wrap in the SST construction gives the cable an additional layer of protection from fire, helping it to meet the highest CPR classifications more easily. PoE (Power over Ethernet) capability is also improved as the isolation wrap helps to dissipate heat out of the conductor pairs, reducing the negative impact of internal temperature rises within the cable when delivering power to any PoE device.

Summary of Advantages Over Traditional Cat 6A U/UTP Cable

- Improved alien crosstalk performance
- Better electrical performance for network installations or modifications
- Smaller cable diameter, more flexible, improved airflow
- Less containment required as the fill ratio is significantly reduced
- Easier and faster to install
- Reduced Carbon Footprint
- Reduced weight
- Easier to transport
- Easier and significantly faster to terminate
- Improved PoE performance

DISCONTINUOUS FOIL TAPE U/UTP CABLE

The discontinuous foil tape U/UTP cable works on a similar principle as the continuous isolation wrap U/UTP cable, but instead of a metal foil, uses a discontinuous foil tape around the four twisted pairs. The discontinuous foil segments break the end-to-end continuity of the tape, creating opposing magnetic fields between the segments and reducing the noise coupling from the tape and that associated with AXT. The length of foil segments can be fixed or variable. Variable segmentation can have superior performance over fixed segmentation and allow for further reductions in cable diameter.

Advantages - SST Cable Over Discontinuous Foil Tape U/UTP Cable

For U/UTP channels, a full isolation wrap cable construction, as utilized in Leviton's SST cable, provides the best protection for EMI. This U/UTP system, that is most similar to a fully shielded installation, provides better coverage than a discontinuous foil construction that has less protection. In addition, a full isolation wrap construction is superior in EMI protection over a discontinuous isolation wrap U/UTP cable construction as the discontinuous wrap design has more "entry paths" for interfering signals, and potential for degradation of the desired signal.



DISCONTINUOUS FOIL TAPE U/UTP CABLE
CROSS SECTION

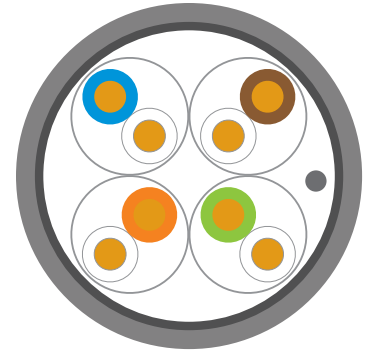
Additionally, the segmentation required in the discontinuous foil tape adds complexity into manufacturing in order to control the gaps that are required at specified intervals along the length of cable. This is not an issue when manufacturing a continuous isolation wrap and therefore helps reduce overall cost as well as providing better reliability in cable performance.

Summary of Advantages Over Discontinuous Foil Tape U/UTP Cable

- Better protection from electromagnetic interference
- Easier to manufacture and typically lower cost
- More reliable performance

CAT 6A SHIELDED CABLE

Cat 6A shielded cable is specifically designed to reduce alien crosstalk and interference from other external sources of noise. Typically, an isolation wrap/braid and a conductive drain wire in shielded cables act together to prevent external noise from coupling onto the twisted pairs. In turn, it also helps prevent any electrical noise from leaking out and onto adjacent cables. However, for the shielding to work correctly and as intended, there must be a consistent low impedance to ground along the full length of the network. Any impedance variations may cause changes in the voltage potential difference with respect to ground which can create problems that could reduce or remove the overall shielding effectiveness.



SHIELDED CABLE CROSS SECTION

To work as intended, shielded cables, jacks, and patch cords, must be used in a fully shielded channel. Additional drain wires must be terminated correctly and maintain end-to-end continuity to ground. If not properly grounded, under fault conditions the cable can become a pathway for high level currents, creating a potential risk to active equipment and/or personnel interacting with the structured cabling system. Shielded systems only work effectively when installed correctly and are not subjected to physical change or handling afterwards. If not installed with the required attention to proper grounding, the shielded system can encounter problems with ground voltage offsets and ground loops being introduced during installation or after later modifications to the network. In summary, shielded cables require extra care, time, and attention during and after installation, and cannot be used within a non grounded U/UTP channel.

Advantages – SST Cable Over Shielded Cable




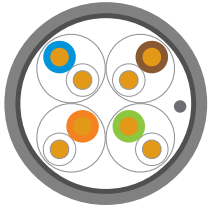
The Leviton SST design installs in the same manner as any traditional U/UTP cable and is used in conjunction with unshielded jacks. There are no foil screens, foil pairs, or drain wires within the SST cable and therefore no terminating foils or drain wires into jacks, which can be both time consuming and costly during installation. The SST cable is also lighter and more flexible than shielded S/FTP and F/FTP constructions.

Summary of Advantages Over Shielded Cable

- Easier and faster installation
- Easier and faster termination
- Easier to maintain network
- Lower cost
- Improved cable flexibility versus S/FTP and F/FTP shielded constructions
- Reduced weight versus S/FTP and F/FTP shielded constructions
- No associated shielding problems relating to ground offsets or loops

CAT 6A CABLE CONSTRUCTION COMPARISON

Leviton engineers have conducted extensive testing to see how each of the Cat 6A cable constructions would score against one another in a selection of typical criteria when choosing a cable. Table 3 below shows the results of this comparison, with the lowest numbers performing the best. SST, with its continuous isolation wrap construction, has a clear advantage over the other constructions.

CABLE CONSTRUCTION RATINGS				
Main Criteria for Cable Selection	SST with Continuous EMI Isolation Wrap	Traditional U/UTP	Discontinuous Foil Tape U/UTP	Shielded
Cross Section				
AXT Suppression	2	4	2	1
PoE Bundling Performance	2	4	2	1
Weight	1	4	1	3
Flexibility	1	4	1	3
Ease of Installation	1	3	1	4
Termination Times	1	3	1	4
Cost to Manufacture	1	2	3	4
Total	9	24	11	20

Rating: 1= Best, 4= Worst

Table 3

CAN THE USE OF ISOLATION WRAP IN A U/UTP CABLE CONSTRUCTION LEAD TO PERFORMANCE ISSUES DUE TO EMI COUPLING OR ANTENNA EFFECTS?

Laboratory testing shows that external noise sources have reduced impact on cables with isolation wraps compared to products without. The measured results confirm the expectation that materials designed to act as a barrier add protection.

From electrical theory and analysis, we know that any external signals do not have a simple path for that interference to propagate to the transmitting copper pairs. Electromagnetic interference (EMI) is more likely to reflect or couple between the isolation wrap and the surrounding environment than make its way onto the wrap. For any external signal that does make its way onto the wrap the isolation wrap prevents direct interaction between the external signals and the copper pairs.

Another factor that sometimes gets discussed in relation to the performance of structured cabling channels is the antenna effect. In theory, the metallic element within an isolation wrap could act as antenna to unwanted signals, and could couple signals into a system or reflect them in a pattern around the wrap. However, for this to happen the metallic element must have the precise length and alignment to interact with the unwanted signal in this way, so the probability of occurrence is low. In addition, analysis has shown that the noise that couples onto an the isolation wrap in Leviton's SST cable is actually in the range of 100 to 1,000 times smaller in magnitude than the noise that is coupled onto a twisted pair in a U/UTP cable without an isolation wrap in the same environment. This is due to the internal pairs' well-defined and controlled common mode impedance to the ground plane that is provided by the isolation wrap.

There are two types of signal disturbers that can affect the noise immunity performance of balanced twisted-pair cabling: those below 30 MHz and those above 30 MHz. At frequencies below 30 MHz, noise currents from the environment can penetrate the shielding / screening provided by the isolation wrap and affect the twisted-pairs. However, the simplified loop antenna model shows that the magnitude of these signals is substantially smaller (and mostly attenuated due to the absorption loss of the aluminium foil), meaning that twisted-pairs in a traditional U/UTP cable without an isolation wrap, in the same environment, are actually subjected to much a higher electric field strength. The balance performance of Cat 6A U/UTP cables are generally sufficient up to 30 MHz to ensure minimum susceptibility to disturbance from these noise sources regardless of the presence of an isolation wrap. At frequencies above 30 MHz, noise currents from the environment cannot penetrate the isolation wrap due to skin effects and therefore the internal twisted-pairs are fully immune to interference. In summary, the antenna effect does not impact performance in Leviton's SST cable.

Interference in any structured cabling channel is strongest at connection points. The impedance changes and irregularities in the transmission line at these locations offer the potential for modal coupling to occur and external signals to enter the transmission mode of the pairs. Connector and cord design can improve the balance of the individual components and the channel. A well-balanced channel will reject common-mode noise coupling and assure performance. This balance is achieved through a combination of high performance cable, connectors, and patch cords, and is quantified by the TCL (Transverse Conversion Loss) and ELTCTL (Equal Level Transverse Conversion Transfer Loss) metrics. These important metrics are specified in the standards and should be reviewed when assessing a U/UTP channel for performance in the presence of interference. Leviton SST, when used in conjunction with Leviton ATLAS™ or EXTREME™ connectivity, provides significant margin headroom above the Cat 6A standards for TCL and ELTCTL, further assuring its excellent immunity to interference within U/UTP channels.

ALIEN CROSSTALK (AXT) - PERFORMANCE COMPARISON OF CONSTRUCTIONS

AXT is widely considered as the limiting factor in the overall signal transmission speeds of 10GBASE-T traditional unshielded systems. Improved active noise cancellation technology of components in the transceivers can overcome much of the system's predictable internal crosstalk. However, the same transceivers are not always capable of cancelling the unpredictable nature of AXT created when cables are bundled together or have additional unwanted EMI from other sources.

To examine the effectiveness of reducing AXT across different cable constructions in a bundled 6-around-1 like for like configuration, lab testing was carried out using three different cable constructions using Fluke DSX-5000 Tester Units. Figures 2 and 3 below demonstrate the improvement in AXT performance at both near and far end when a traditional U/UTP cable is replaced with a SST continuous isolation wrap U/UTP cable. Both of these configurations shared the same unshielded components in the Channel, with only the horizontal base cable swapped. It can be seen where the traditional U/UTP starts to reach the ISO 11801 Class E_A limits for AXT, the SST improves margins by approximately 20 dB in PS ANEXT and PS AACR-F across the entire frequency range up to 500 MHz. This allows for much higher confidence levels in successfully transmitting and receiving reliable data through the SST U/UTP system.

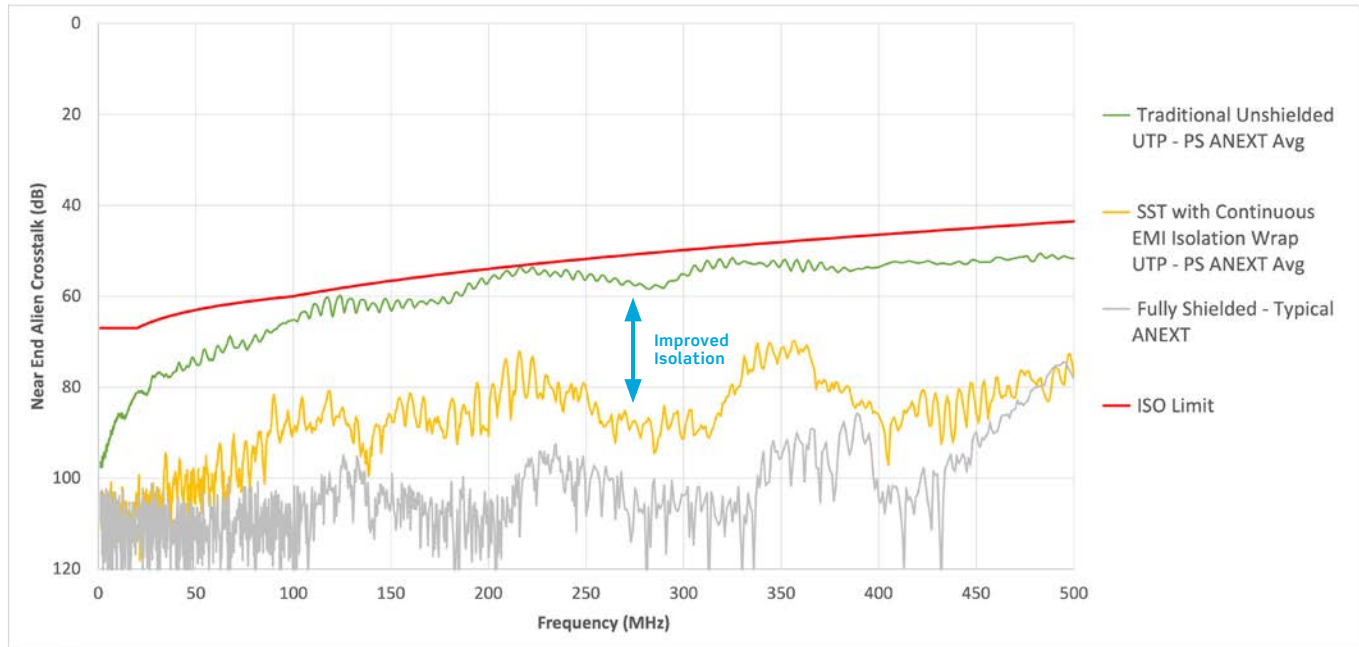


Figure 2

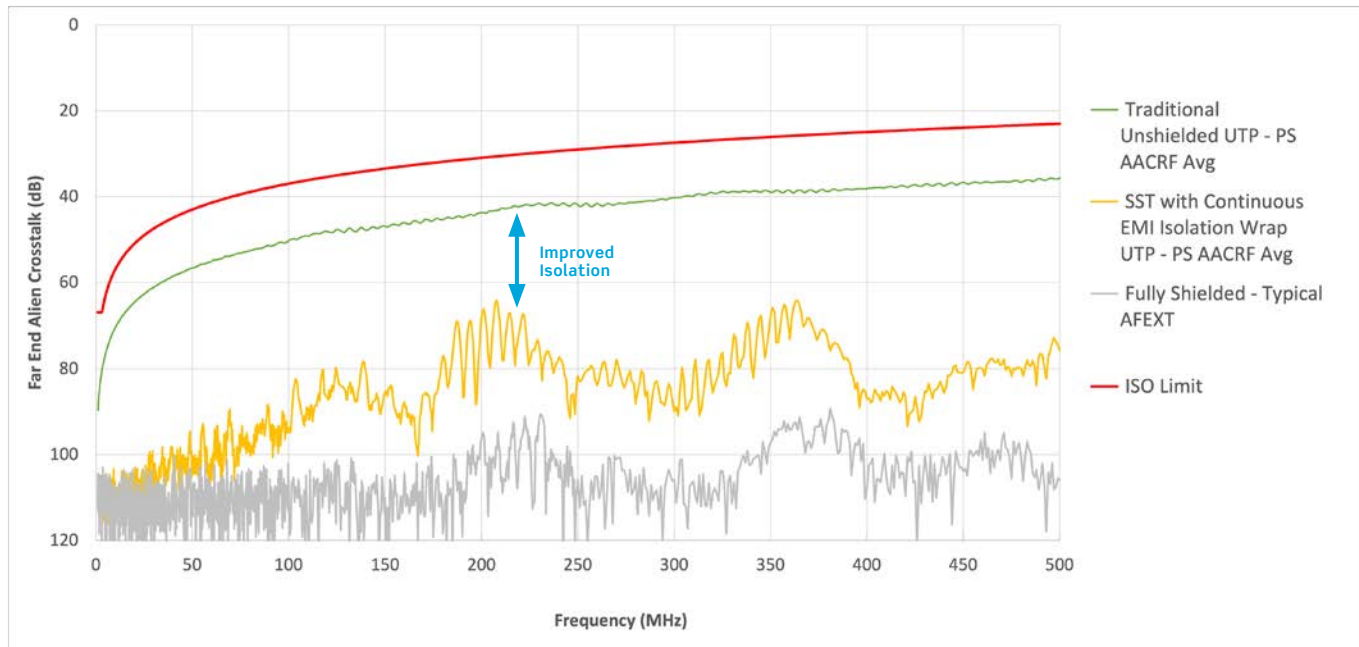


Figure 3

CONCLUSION

This paper highlights the benefits of using the Leviton SST cable design with a continuous isolation wrap over current typical Cat 6A designs of traditional U/UTP, shielded, and discontinuous foil tape cable constructions. The Leviton SST cable with Supreme Speed Technology provides a layer of extra protection to improve overall performance of the cable while negating the need to terminate screens or bond cables to ground.

Today's networks must be fast and reliable, with the flexibility to handle ever-increasing data demands. Leviton can help expand your network possibilities and prepare you for the future. Our end-to-end cabling systems feature robust construction that reduces downtime, and performance that exceeds standards. We offer quick-ship make-to-order solutions from our US and UK factories. We even invent new products for customers when the product they need is not available. All of this adds up to the **highest return on infrastructure investment.**

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